

APPENDIX E

Interview Documentation

RECORD OF COMMUNICATION						
Site Name: Burgess Mill			Location (city): Berlin, New Hampshire			
Communications with: Fred McGarry, P.E., NHDES - Waste Management Division						
Location: Concord, New Hampshire			Phone: (603)271-3503			
Communication via		Telephone		Letter	<input checked="" type="checkbox"/>	In Person
Recorded By: B. Smith			Of: H & A			
At: (time): 0800 - 0830			On (date): 19 February 2002			
Re: Primary NHDES concerns re: site						
<p>Summary of Communication: Reviewed Cell House status, received draft sediment sampling results for mercury (by R.F. Weston, samples collected 2-4 December 2001). Fish tissue sampling results reportedly relatively low. Low levels (~AGQS) of mercury in discharge from Cell House area. Wastewater sludge from Burgess Plant not likely an issue for disposal due to large amounts of "clean" process water (18 - 20 mgd). Additional investigation at Cell House area likely required. Likely sludge went to Dummer or Mt. Carberry landfills.</p> <p>T-1 Transformer Area contains elevated PCBs in soil and groundwater. Request in from NHDES to EPA for NHDES to take enforcement lead, based on groundwater impacts.</p> <p>No. 6 fuel oil spills from rail transfers.</p>						
Conclusions/Required Action/Follow-up: Consider during report development						

RECORD OF COMMUNICATION						
Site Name: Burgess Mill			Location (city): Berlin, New Hampshire			
Communications with: Peg Bastien, P.E., NHDES - Waste Management Division						
Location: Concord, New Hampshire			Phone: (603)271-3503			
Communication via		Telephone		Letter	X	In Person
Recorded By: B. Smith			Of: H & A			
At: (time): 0830 - 0910			On (date): 19 February 2002			
Re: Primary NHDES concerns re: site						
<p>Summary of Communication: Peg is the NHDES project manager for the Cell House and T-1 transformer areas remediation. NHDES has not focused on the manufacturing area of the site. Mary Garren of EPA is working with Cascade on assessing environmental liabilities. PCBs present in soil and groundwater at the T-1 Transformer area. The R&D Building is being managed by Joyce Bledsoe, NHDES, under the Brownfields program. Additional Site Investigation is required at the Cell House site. A GMP application was received by NHDES for the Cell House, and the NHDES response is pending (additional bedrock investigation likely required). Tom White is the NHDES contact w/r/t the Burgess WWTP lagoons. Wendy Bonner is the NHDES contact w/r/t RCRA status. Fish and Game Department performed limited fish tissue analysis (2 samples) with "none detected" results.</p>						
<p>Conclusions/Required Action/Follow-up: Consider during report development. H&A contact Mary Garren of EPA</p>						

RECORD OF COMMUNICATION						
Site Name: Burgess Mill			Location (city): Berlin, New Hampshire			
Communications with: Bob Goodreau, Chief, Berlin Fire Department						
Location: Berlin, New Hampshire			Phone: 603.752.3135			
Communication via	<input checked="" type="checkbox"/>	Telephone	<input type="checkbox"/>	Letter	<input type="checkbox"/>	In Person
Recorded By: N. Keith			Of: H & A			
At: (time): 08:50			On (date): 19 February 2002			
Re: Environmental Records, Tank Registrations, and Spill Reports						
Summary of Communication: Mr. Goodreau indicated that the Fire Department's records were not public documents. He was unwilling to allow us to view them.						
Conclusions/Required Action/Follow-up: Called Sue Tremblay at City Assessor's Office – she indicated that she would set up a time for us to view documents.						

RECORD OF COMMUNICATION						
Site Name: Burgess Mill			Location (city): Berlin, New Hampshire			
Communications with: Sue Tremblay, Assessor, City of Berlin						
Location: Berlin, New Hampshire			Phone: 603.752.7532			
Communication via	<input checked="" type="checkbox"/>	Telephone	<input type="checkbox"/>	Letter	<input type="checkbox"/>	In Person
Recorded By: N. Keith			Of: H & A			
At: (time): 09:15			On (date): 19 February 2002			
Re: City Environmental Records						
Summary of Communication: Mrs. Tremblay inquired at the Health Department on our behalf and was told that they do not maintain records on the Burgess Mill site related to environmental issues. She also indicated that she would contact the Fire Department regarding the availability of their records.						
Conclusions/Required Action/Follow-up: None						

RECORD OF COMMUNICATION						
Site Name: Burgess Mill			Location (city): Berlin, New Hampshire			
Communications with: Tom White, NHDES – Water Division						
Location: Concord, New Hampshire			Phone: (603)271-3503			
Communication via	<input checked="" type="checkbox"/>	Telephone	<input type="checkbox"/>	Letter	<input type="checkbox"/>	In Person
Recorded By: B. Smith			Of: H & A			
At: (time): ~3:00 p.m.			On (date): 19 February 2002			
Re: Burgess Mill WWTF sludge disposal						
Summary of Communication: WWTF sludge disposed of at Mt. Carberry landfill. Sludge was disposed of at Dummer landfill in the past. Were some “issues” at Cascade WWTF prior to shutdown (summer 2001). Burgess WWTF working alright.						
Conclusions/Required Action/Follow-up: Consider during report development.						

RECORD OF COMMUNICATION						
Site Name: Burgess Mill			Location (city): Berlin, New Hampshire			
Communications with: Lee Dube, Berlin Fire Department						
Location: Berlin, New Hampshire			Phone: 603.752.3135			
Communication via		Telephone		Letter	X	In Person
Recorded By: N. Keith			Of: H & A			
At: (time): ~9:00			On (date): 20 February 2002			
Re: Environmental Records, Tank Registrations, and Spill Reports						
Summary of Communication: Mr. Dube provided spill reports for the years 1990 through 2002. He indicated that the Fire Department did not have records of tank registrations for the site.						
Conclusions/Required Action/Follow-up: None						

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RECORD OF COMMUNICATION						
Site Name: Burgess Mill			Location (city): Berlin, New Hampshire			
Communications with: Roland Viens, Superintendent, Berlin Water Works						
Location: Berlin, New Hampshire			Phone: 603.752.1677			
Communication via		Telephone		Letter	X	In Person
Recorded By: N. Keith			Of: H & A			
At: (time): ~10:30			On (date): 20 February 2002			
Re: Drinking Water Protection Areas						
Summary of Communication: Mr. Viens indicated that the Burgess Mill was not located in or upgradient of a drinking water protection area. He provided maps showing the protected areas.						
Conclusions/Required Action/Follow-up: None						

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RECORD OF COMMUNICATION						
Site Name: Burgess Mill			Location (city): Berlin, New Hampshire			
Communications with: Mike Witten, St. Lawrence Northern Rail Road						
Location: Berlin, New Hampshire			Phone: (800)848-4408, x215 (Supervisor; Steve Kunsen)			
Communication via		Telephone		Letter	<input checked="" type="checkbox"/>	In Person
Recorded By: B. Smith			Of: H & A			
At: (time): ~11:30 a.m.			On (date): 20 February 2002			
Re: St, Lawrence/Northern maintenance shed operations						
<p>Summary of Communication: Maintains rail cars (lubes, oils, cleans, welds). Waste oil stored in plastic or steel tanks and taken off site by Safety-Kleen. Safety-Kleen parts washer. Wash waster drains through cracks in floor near grease pit (location of waste oil, lube oil and caustic use and storage). Property leased from Pulp & Paper of America for past ~4 years. Burgess Mill fire protection inspectors visit ~weekly. Oil-soaked sorbant materials go to landfill for disposal.</p>						
Conclusions/Required Action/Follow-up: Consider during report development.						

RECORD OF COMMUNICATION						
Site Name: Burgess Mill			Location (city): Berlin, New Hampshire			
Communications with: Frank Ramsey, PPA Safety Director (both Burgess and Cascade mills).						
Location: Berlin, New Hampshire			Phone: PPA			
Communication via		Telephone		Letter	X	In Person
Recorded By: B. Smith			Of: H & A			
At: (time):			On (date): 20 and 21 February 2002			
Re: Site conditions, Burgess Mill (tour guide for B. Smith and D. Allen)						
Summary of Communication: Mr. Ramsey escorted B. Smith and D. Allen during their two-day site visit. Mr. Ramsey identified process areas and equipment, and assisted the assessors with accessing interior and exterior areas of the site.						
Conclusions/Required Action/Follow-up: Consider during report development.						

RECORD OF COMMUNICATION						
Site Name: Burgess Mill			Location (city): Berlin, New Hampshire			
Communications with: Michael Perreault, Security Department						
Location: Berlin, New Hampshire			Phone: PPA			
Communication via		Telephone		Letter	<input checked="" type="checkbox"/>	In Person
Recorded By: J. Limbrunner			Of: H & A			
At: (time):			On (date): 20 and 21 February 2002			
Re: Site conditions, Burgess Mill (tour guide for T. Benedict and J. Limbrunner)						
Summary of Communication: Mr. Perreault escorted T. Benedict and J. Limbrunner during their two-day site visit. Mr. Perreault identified processes and equipment in areas including the Kraft Mill, Caustics, T-1 Transformer, Central Steam, and Riverside Mill. He assisted the assessors with accessing interior and exterior areas of the site.						
Conclusions/Required Action/Follow-up: None.						

RECORD OF COMMUNICATION						
Site Name: Burgess Mill			Location (city): Berlin, New Hampshire			
Communications with: Ray Danforth, former Crown Vantage environmental compliance manager (1980- 1999)						
Location: Berlin, New Hampshire			Phone: N/A			
Communication via		Telephone		Letter	X	In Person
Recorded By: B. Smith, D. Allen			Of: H & A			
At: (time): 0815 - 0910			On (date): 21 February 2002			
Re: General Site information						
<p>Summary of Communication: Primary areas of environmental liability per M. Danforth included: landfill leachate to WWTF; long-term leaks in wastewater piping; asbestos and lead-paint abatement issues; miscellaneous spills (petroleum and black liquor); residual PCBs; coal ash fill beneath Burgess Mill main parking area. USTs were all closed in early 1980s in response to new UST regulations. Sediments dredged from Cross Dam circa 1990 not likely mercury-containing, due to intervening dams. Dredge spoil disposal location unknown. Much of the debris from demolished buildings likely remained on site. Oily gravel from petroleum spills to Dummer or Mt. Carberry landfills. All PCB wastes off site for incineration. Riverside Mill contained asbestos-based paper manufacturing process (late 1960s to mid-1970s). Mercury instruments, solvents for electrical motor cleaning used in building. Recently used for warehousing petroleum products. Wastewaters to river prior to connection to Burgess WWTF (1976). 1996 Sevee & Maher inventory of pipes going to river, initiated in response to local citizen's action, was reconciled by several followup studies. Citizen's action was dropped (per Tammy LaVoie, current environmental manager, in separate conversation this date and location).</p>						
<p>Conclusions/Required Action/Follow-up: This information was considered during development of the report.</p>						

RECORD OF COMMUNICATION						
Site Name: Burgess Mill			Location (city): Berlin, New Hampshire			
Communications with: Don Mercier, PPA Power Systems Manager (high voltage power delivery to facility transformers, both Burgess and Cascade mills)						
Location: Berlin, New Hampshire			Phone: PPA			
Communication via		Telephone		Letter	X	In Person
Recorded By: B. Smith			Of: H & A			
At: (time): ~10:00 a.m.			On (date): 21 February 2002			
Re: Burgess Maintenance Building, transformers (general)						
<p>Summary of Communication: Maintenance Building floor drains were installed for snow melt from trucks and piped to Berlin POTW with sanitary waste. High-power transformers all have containment per FERC and NHDES regulations. Periodic change-out / maintenance program for transformers. Not using PCE to leach PCBs from high-power transformers (contact Bob Chauvette at Burgess for additional information regarding power management from the low side of the high-power transformers Don is responsible for).</p>						
Conclusions/Required Action/Follow-up: Consider during report development.						

RECORD OF COMMUNICATION						
Site Name: Burgess Mill Service Garage			Location (city): Berlin, New Hampshire			
Communications with: Jerry Lavoie, Service Mechanic						
Location: Berlin, New Hampshire			Phone:			
Communication via		Telephone		Letter	X	In Person
Recorded By: T. Benedict			Of: H & A			
At: (time): 13:30			On (date): 21 February 2002			
Re: Service Garage Site Inspection						

Summary of Communication: Mr. Lavoie, Service Mechanic, was interviewed regarding operations at the Service Garage, located on Hutchins Street. Storage of virgin petroleum and hazardous substances on-site includes the following: (2) 300-gal. aboveground storage tanks (ASTs) for #2 heating fuel, (1) 275-gal. AST for kerosene for the pressure washer, (5) 275-gal. ASTs for various grades of lubricating oils, up to 10 drums for various grades of lubricating and hydraulic oils, (2) 200-gal. ASTs for hydraulic oils, and (2) Safety Kleen parts washer units (serviced every few weeks by an outside vendor). ASTs for gasoline (2,700-gal.) and diesel fuel (1,800-gal.) for vehicle refueling are located behind the Service Garage, to the east of the building on bare ground with no secondary containment (ground surface mostly covered by snow). Painted markings on the front of the building indicated the past use of up to three underground storage tanks (USTs) for gasoline, diesel fuel, and heating fuel. An area of cut and patched pavement was observed in the parking lot in front of the building. Mr. Lavoie reported that he believed that the USTs had been removed from the cut and patched area approximately five years ago; no documentation was available to verify this.

Wastes stored at the site include the following: (1) 275-gal. AST for waste oil, (2) 200-gal. totes for waste oil (one tote leaking to garage floor), (3) drums for waste antifreeze, several lead-acid storage batteries stored on floor by the "Hazardous Waste Vault". Waste oil is reportedly sent down to the Burgess Mill plant to be burned on-site; antifreeze is shipped off-site for recycling. The "Hazardous Waste Vault", located in the northeast corner of the building, has walls on three sides, a concrete floor, and is accessed by a gated chain-link fence that was locked at the time of the site inspection. The "vault" is reportedly used as the central, <90-day hazardous waste storage area for the entire Burgess Mill site. While the inside of the "vault" was not accessible for close inspection, it was found to contain three large transformers bearing "PCB" labels, two small (<5 gallon) containers bearing "hazardous waste" labels, one drum bearing a "PCB" label, and approximately (30) unlabeled drums and overpack containers (site contacts could not verify whether these containers were empty or full). Hazardous wastes are reportedly shipped off-site for treatment/disposal. The "vault" was formerly used as a large paint booth until converted to the present use. Mr. Lavoie indicated that painting operations are currently done in the vehicle service bays with the doors open for ventilation, or painting is done outside in the rear parking lot. Mr. Lavoie indicated that paint guns are cleaned with lacquer thinner that is reused until spent; spent lacquer thinner is then soaked into Speedy Dry and then sent for disposal at the Mt. Carberry landfill. (continued)

Summary of Communication with Jerry Lavoie (continued):

Wastewater from pressure washing of vehicles, parts, and equipment is generated at the indoor wash bay located along the western side of the building. The wash water discharges to grated floor trenches in the Wash Bay that drain to a sump that is tied into the building floor drainage system. The sump apparently functions only as a grit settling chamber, and there is reportedly no oil/water separator that serves the Service Garage. Mr. Lavoie indicated that settled grit and sludge from the sump is periodically scooped out with a backhoe and disposed of at the Mt. Carberry landfill. Wastewaters from the Wash Bay and several floor drains in the Service Garage reportedly drain to the sanitary sewerage system that discharges to the Burgess Mill wastewater treatment plant (WWTP). Prior to the tie-in to the Burgess Mill WWTP in the early 1970's when that plant was constructed, wastewaters from the Service Garage reportedly discharged to the municipal sanitary sewerage system. The Service Garage is believed to have been constructed in the 1940's.

Several areas of heavily oil-stained floors were observed in the Service Garage, including the vehicle service pit, the area around the virgin lube oil tanks, and the area around a leaking waste oil storage tote. Mr. Lavoie indicated that oil-soaked Speedy Dry from routine floor sweeping and spills is typically disposed of at the Mt. Carberry landfill.

Behind the Service Garage, to the east of the building, approximately 20 vehicles were stored or parked, several tanks and pieces of large unused equipment (likely associated with wastewater treatment systems), and approximately 20 drums were observed. Many of the drums were frozen in-place and partially buried in snow; a few of the drums were full or partially full, as determined by tapping on the drums.

RECORD OF COMMUNICATION						
Site Name: Burgess Mill			Location (city): Berlin, New Hampshire			
Communications with: Heather Carpenter, Records Department, New Hampshire						
Department of Environmental Services						
Location: Berlin, New Hampshire			Phone: 603.271.8808			
Communication via	<input checked="" type="checkbox"/>	Telephone	<input type="checkbox"/>	Letter	<input type="checkbox"/>	In Person
Recorded By: N. Keith			Of: H & A			
At: (time): 14:00			On (date): 22 February 2002			
Re: UST Registrations/Closure Reports						
Summary of Communication: Mrs. Carpenter checked the NHDES's records and indicated that they had no records relating to USTs for the site. She said that NHDES started keeping records in the 1980s and that their records are incomplete prior to the mid-80s.						
Conclusions/Required Action/Follow-up: None						

RECORD OF COMMUNICATION						
Site Name: Burgess and Cascade Mills, PPA			Location (city): Berlin & Gorham, New Hampshire			
Communications with: Tammie Lavoie, Manager of Environmental Services, PPA						
Location: Berlin, New Hampshire			Phone: 603-342-2361			
Communication via		Telephone		Letter	<input checked="" type="checkbox"/>	In Person
Recorded By: D.C. Allen			Of: H & A			
At: (time): Approx. 8:30 to 13:30			On (date): 27 February 2002			
Re: Site info and walkover						
<p>Summary of Communication:</p> <p>Tammie provided site access for follow-up walk-overs of the Burgess (Berlin) and Cascade Flats (Gorham) Mills. Tammie provided access to several areas previously locked at both locations. At the Gorham Mill, site access was also provided by Mr. Al Reynolds of PPA.</p> <p>Tammie also provided additional information regarding North Yard (Burgess) PCBs sampling and documentation regarding UST removals.</p>						
Conclusions/Required Action/Follow-up: None						

APPENDIX F

Preliminary Asbestos Survey

- Draft -

March 4, 2002

Mr. Jim Griswold
Senior Hydrogeologist
Haley and Aldrich, Inc.
340 Granite Street, Third Floor
Manchester, New Hampshire 03102-4004

RE: Preliminary Site Visit – Asbestos Containing Materials Draft
Pulp & Paper of America Facility
Berlin, New Hampshire

DRAFT

Dear Mr. Griswold;

In accordance with our recent communications RPF Associates Inc. (RPF) completed a preliminary site visit at the Pulp & Paper of America LLC (PPA) property located in Berlin, New Hampshire. The site visit was completed by Dennis N. Francoeur Jr., CIH CSP on February 27, 2002. The purpose of the site visit was to visually review the condition of presumed asbestos containing materials (PACM) and asbestos containing materials (ACM) located within the Riverside Mill, Central Steam Plant and the Kraft Mill–Old Boiler area and provide this letter of preliminary findings including initial preliminary cost estimates for cleaning of the areas. While on-site, RPF was also asked to review an exposed dirt banking near the Railroad Shop located northwest of the A Frame. Limitations of this preliminary survey are discussed herein and are also provided in Attachment A. RPF was also provided a copy of documentation entitled Burgess Pulp Mill Asbestos Locations & Amounts (PPA Inventory, provided as Attachment B) for preliminary review

Observations and Findings

After an initial site meeting with Douglas Allen, James Limbrunner of Haley and Aldrich and Tammie Lavoie of PPA, RPF started the site visit with Mr. Francis Ramsey, Safety Director for the site for PPA. From our discussions with Mr. Ramsey, the PPA facility has three employees trained and licensed to remove ACM and PPA routinely completes small-scale removal projects. PPA was listed by the State of New Hampshire as a licensed asbestos abatement contractor No. C-7 with an expiration date of January 24, 2001. An ACM labeling program is also reported to be in place including the labeling of non-ACM replacement thermal system insulation (TSI) materials as non-ACM when abatement activities are completed. RPF was also provided a copy of a summary of ACM inventory (PPA Inventory) at the facility, which indicates that 98 percent of the mill, had been surveyed as of January 22, 2001. Estimated quantities of ACM listed in the Inventory were not measured or confirmed during this preliminary site visit. Each of the areas will be described separately below.

River Side Mill

The River Side Mill is a wooden structure, which previously housed paper machines and is now used for storage. Accessible floors and walls were wooden with several areas of floor covered with metal sheeting. Limited accessible ACM was observed as we walked the length of the building, south to north, to access the ladder to the basement area. The basement area has a limited concrete walkway along the west side of the building and a combination of dirt, stone, concrete and wooden pathways for most of the basement. Ceiling height and access to pipes is varied and limited in some locations. Many of the pipes in the area are void of insulation. A main steam line does runs most of the length of the basement and the insulation is in varying states of repair. Several smaller lines are also insulated in the area. Portions of the ACM insulation have been removed, replaced with non-ACM insulation in some places and other sections wrapped in poly sheeting. Danger caution tape is up at many locations with asbestos warning signs also present. In some areas the caution tape has fallen to the ground. The pipe insulation could be classified as damaged to significantly damaged in localized areas.

The extent of soil contamination could not be determined visually but is anticipated to be present based on the conditions observed. Initial estimates indicate that an area of approximately 15' by 180' would need to be evaluated and sampled to determine the presence or absence of ACM contamination in the soil in the basement. Suspect materials were observed in several areas however with the presence of old dried paper pulp, we were not able to determine what materials on the floor may be ACM or just dried paper pulp. Employee access in this area is reported to be limited to security personnel accessing two fire control-valve rooms. Replacement non-ACM insulation was observed stored in one area. RPF was not able to determine if representative employee exposure determinations had been completed for employees who may work in this basement area.

The PPA Inventory lists approximately 170 linear feet of insulation on the 140# steam line and approximately 315 feet of other thermal system insulation (TSI) in the basement area. Some of this material may have been removed since the printing of the Inventory. The Inventory also lists approximately 850 square feet of 9" x 9" green floor tile as containing chrysotile asbestos, 300 square feet of transite ceiling panels and 150 square feet of transite wall panels on the roof. The flooring and transite were not observed during our site visit.

Central Steam Plant

The ACM within the Central Steam Plant is in varying conditions. Accessible ACM along main travel areas and passageways was in good condition with limited damage. Areas with evidence of minimal employee access varied from

good to damaged condition, with significantly damaged materials observed associated with the older boiler systems that are no longer in service. Our limited site visit indicates that there are three older no longer functioning coal boilers in various stages of dismantling, Boilers Nos. 3, 4, and 5. Suspect ACM was observed associated with these three boilers and associated upper levels had been covered by poly sheeting in some areas to control the release of fibers. Boilers 7 and 14 were also reported to be non-operational. Boilers No. 12 and 9 were operational. Much of No. 9 was covered with new insulation and metal coverings and was in good condition overall. No. 12 was also in good condition overall. Pipe insulation was also observed throughout the building with much of it labeled as either ACM or non-ACM. In general, the ACM was in good condition with localized damage in several locations. Labeling of PACM and ACM was not sufficiently thorough as to what was or what was not ACM. Additionally, limited housekeeping in some areas made it difficult to determine whether debris was ACM. Additional sampling of materials will be required for confirmation.

The PPA Inventory lists approximately 3,000 linear feet of pipe insulation, 3,500 square feet of block and decking insulation, 20,000 square feet of siding as ACM for this building. The estimates for boiler insulation (block) may be an underestimate and may not include the interiors of the boilers and associated breechings. Additional testing will be needed when the boilers are off and the outer metal layers can be accessed. The Inventory also lists approximately 560 square feet of 12" x 12" light green/olive floor tile as chrysotile asbestos and 700 square feet of transite asbestos. Unknown quantities were also listed associated with the line 7 & 8 boiler drum and the mortar within boilers No. 3, 4, and 5.

Kraft Mill – Old Boiler – No. 8 Recovery Boiler

The Recovery Boiler is reported to have been out of service for approximately nine years. Signs on each floor warn employees that the area contains ACM and that precautions should be taken before working on the boiler and associated piping. Many sections of the boiler have been damaged with exposed friable suspect ACM. The boiler is approximately eight stories tall and 25' x 30' plus associated piping. Approximately 50% of the piping is labeled as non-ACM. Four evaporators-tanks labeled as ACM were also present with a diameter of approximately ten feet and height of four stories. Sections of insulation had been replaced with non-ACM. Labeling of PACM and ACM was not always sufficient to what was or what was not ACM. Additionally, limited housekeeping in some areas made it difficult to determine whether debris was ACM. Much of the boiler is still encased with metal siding making access to suspect ACM difficult.

The PPA Inventory lists approximately 5,800 square feet of boiler cavity decking as ACM and 700 square feet of ceiling material. The large evaporators were not included in the inventory and four of the six were labeled as ACM. Additional sampling of materials will be required for confirmation.

Exterior Dirt Banking

An exposed dirt banking was observed adjacent to the railroad shop. Approximately 50 feet of soil bank, one to three feet in height was observed not covered with snow, near various lumber and rail ties. An area of approximately ten feet long had visible suspect ACM in the form of cement board, gasket material, and loose damaged thermal system insulation. A sample of the cement board was reported as 30% chrysotile and a sample of the loose TSI was reported as 10% chrysotile insulation. Additional investigation and sampling will be required to determine the extent and quantity of material present after the snow cover has melted.

The PPA Inventory provided to RPF appears to be a summary of known ACM at the PPA facilities. It lists identified ACM in the form of thermal system insulation, decking, siding, roofing, tanks, ducts boilers and floor tiles. In some instances mud, mortar and mastic materials are mentioned. Actual inspection reports including names and training of inspectors, laboratory certifications, limitations and actual laboratory results were not reviews as part of this preliminary visit. The inventory does not list those materials sampled and determined to not contain asbestos. Other suspect materials, which will require further review and possible sampling by an accredited inspector prior to renovation or demolition activities include but are not limited to the following:

- Construction adhesives, mastics and flashings;
- Floor tile mastics and/or multi-layered systems (expansion papers);
- Window putties and caulks;
- Door and foundation caulks;
- Ceiling tiles;
- Wall boards and joint compounds;
- Ceiling and wall plasters and coatings (sprayed, brushed or troweled on);
- Sprayed on fireproofing
- Transite pipes;
- Laboratory hoods, cabinets and countertops;
- Pipe and valve gaskets;
- Internal insulation of mechanical systems and boilers;
- Electrical insulation; and
- Debris located adjacent to damaged or previously repaired ACM

It is RPF's understanding that PPA was conducting ACM abatement with its own employees and subcontract employees. Extensive analytical data and exposure monitoring data is presumably on file and may provide additional information on the extent of past ACM activities. RPF also understands that PPA operates a permitted landfill of the disposal of ACM. The status of the landfill had not been confirmed as part of this preliminary review.

Preliminary Cost Estimates for Asbestos Abatement

RPF's opinions on the estimated costs for abatement are presented below. Actual final cost will be dependant on a variety of factors. A site-specific work plan, or technical specifications must be developed by an accredited Project Designer and followed to ensure that the regulatory requirements from the State of New Hampshire, US DOL OSHA and US EPA are followed. As part of the development of the site plan for abatement, further survey, review and testing of PACM will be required to more fully delineate the extent of ACM and contamination. Travel expenses must also be considered with contractors due to the location of the facilities. Consideration of impact on costs with the utilization contractors (union or non-union) or licensed employees from the plants should be made when developing the site-specific work plan. Significant short term cost savings may also be available with the use of the permitted PPA landfill. Unit rates are difficult to establish not knowing the size of the projects to be completed, spot removals or full scale abatement of large sections or quantities of ACM. Attachment A includes a summary of ACM remaining at the facilities, which may require abatement in the future.

As an example TSI pipe insulation removal costs based on complexity of the removal and diameter of pipes can range from \$10.00 to \$25.00 per linear foot for interior removal and \$20.00 to \$75.00 per linear foot for exterior removal of pipe insulation. Cost analysis must include considerations for contractor materials, mechanical equipment, technical survey and specification design, industrial hygiene air monitoring and independent (from the removal firm) final industrial hygiene inspection and clearance air testing.

Each of the areas RPF was requested to review will be discussed below utilizing quantity estimates provided in the Inventory provided by PPA.

River Side Mill

The River Side mill contains approximately 485 linear feet of ACM pipe insulation in the basement area. With an estimated cost range of \$10.00 to \$25.00 per linear foot, the estimate may range from \$4,850. to \$12,125. excluding the additional cost pre-cleaning of contaminated soils in the area. Determining the extent of the cleaning will require additional investigation and analytical data.

Abatement of the estimated 850 square feet of ACM floor tiles with a range of \$2.50 to \$5.00 per square foot will range from \$2,125. to \$4,250. Information on the substrate which the flooring is attached to, whether the mastic is to be removed as ACM and the number of layers of floor tile would need to be determined prior to obtaining an actual cost.

Abatement of the estimated 450 square feet of transite sheeting may range from \$4.50 to \$6.00 per square foot excluding consideration of access, space limitations, and fastening systems.

Kraft Mill – Old Boiler – No. 8 Recovery Boiler

Based on the very limited information available at the time of the site visit, estimated costs for the demolition of and removal of the ACM from the No. 8 Recovery Boiler could range from \$100,000. to \$300,000. This includes the approximate values for scrap metals reclamation recovered by the contractor during demolition. However, it is essential that additional investigation, engineering and project design be completed due to the need to demolish the boiler structure as part of the abatement. It should be noted that that if employee access to this area of the facility can be limited to essential personnel only with proper ACM training that the ACM would not need to be removed at this time. ACM removal is not mandatory until such time that a structure is to be renovated or demolished, however the ACM must be maintained in a manner to prevent employee exposure to airborne asbestos fibers.

Central Steam Plant

Based on the limited information available at the time of the site visit, estimated costs for the removal of the ACM from the various boilers and piping systems could range from \$75,000. to \$250,000. per boiler unit. This includes approximate values for scrap metals reclamation recovered by the contractor during demolition. However, it is essential that additional investigation, engineering and project design be completed due to the need to demolish the boiler(s) structure in an active operating steam plant as part of the abatement. Costs associated with this work will be impacted by which portions of the remainder of the Central Steam Plant will be occupied and operational during removal and demolition activities. ACM removal is not mandatory until such time that a structure is to be renovated or demolished, however the ACM must be maintained in a manner to prevent employee exposure to airborne asbestos fibers.

This letter of findings and our opinions of cost estimates for remedial action derived from this preliminary site visit are subject to the attached limitations. Please contact RPF if you have any questions or require additional information or assistance with this important project.

Sincerely
RPF Associates, Inc.

Dennis N. Francoeur Jr., CIH CSP
Principal

Attachments: Attachment A Limitations
Attachment B Summary of ACM Crown Vantage Burgess and Cascade Plants 1/22/01

ATTACHMENT A

PRELIMINARY SURVEY LIMITATIONS

1. The observations and conclusions presented in the Preliminary Letter of Findings were based solely upon the services described herein, and not on scientific tasks or procedures beyond the scope of services as discussed in the proposal and text of the report.

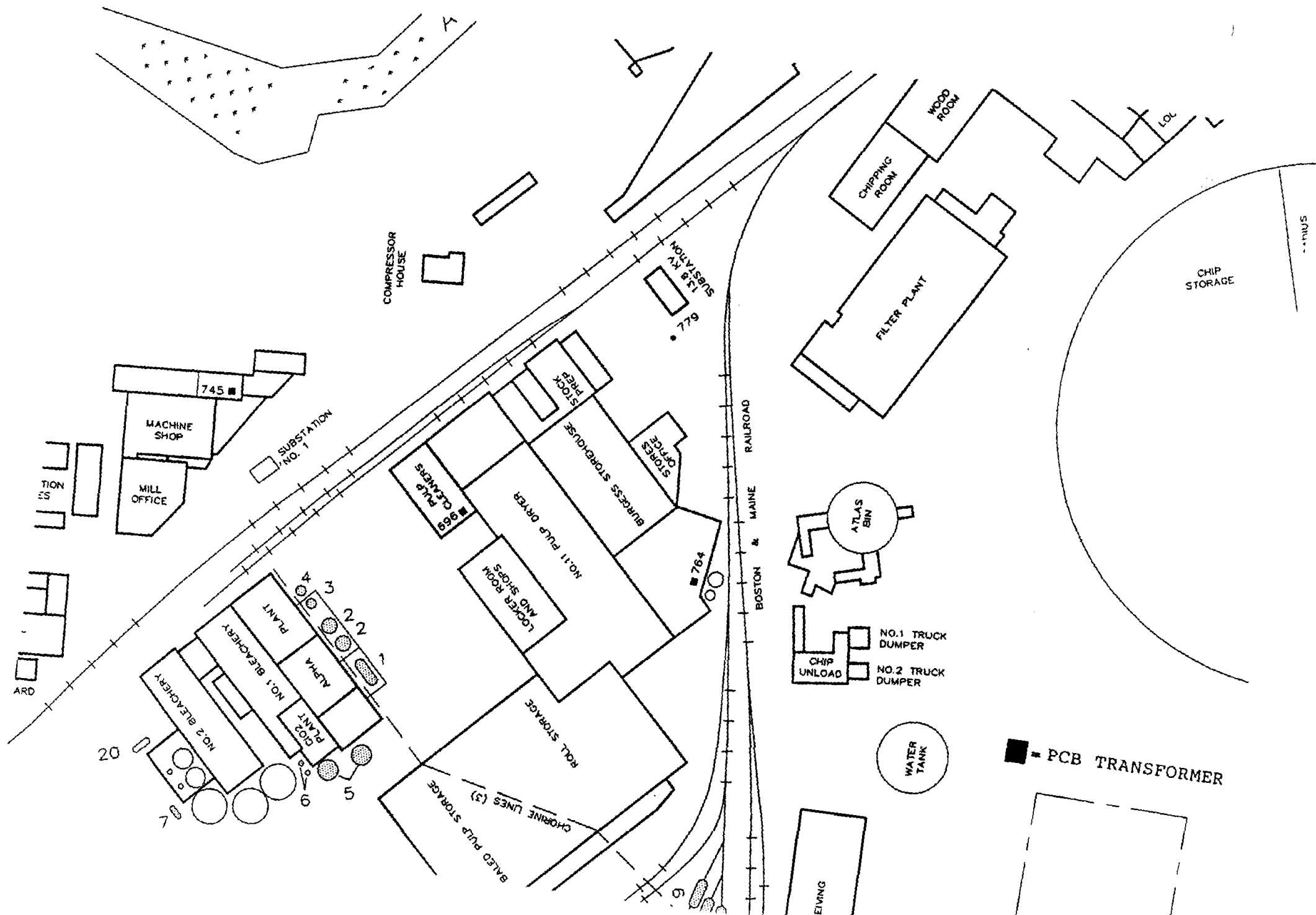
The inspection was limited and included only visual inspections of designated accessible suspect materials and a preliminary, limited review of the PPA Inventory. Initial or supplemental inspections, bulk material testing, and analysis to identify asbestos-containing material (ACM) was not performed during this preliminary survey except as otherwise noted for the spot sampling of the accessible exterior debris on the banking adjacent to the railroad shop.

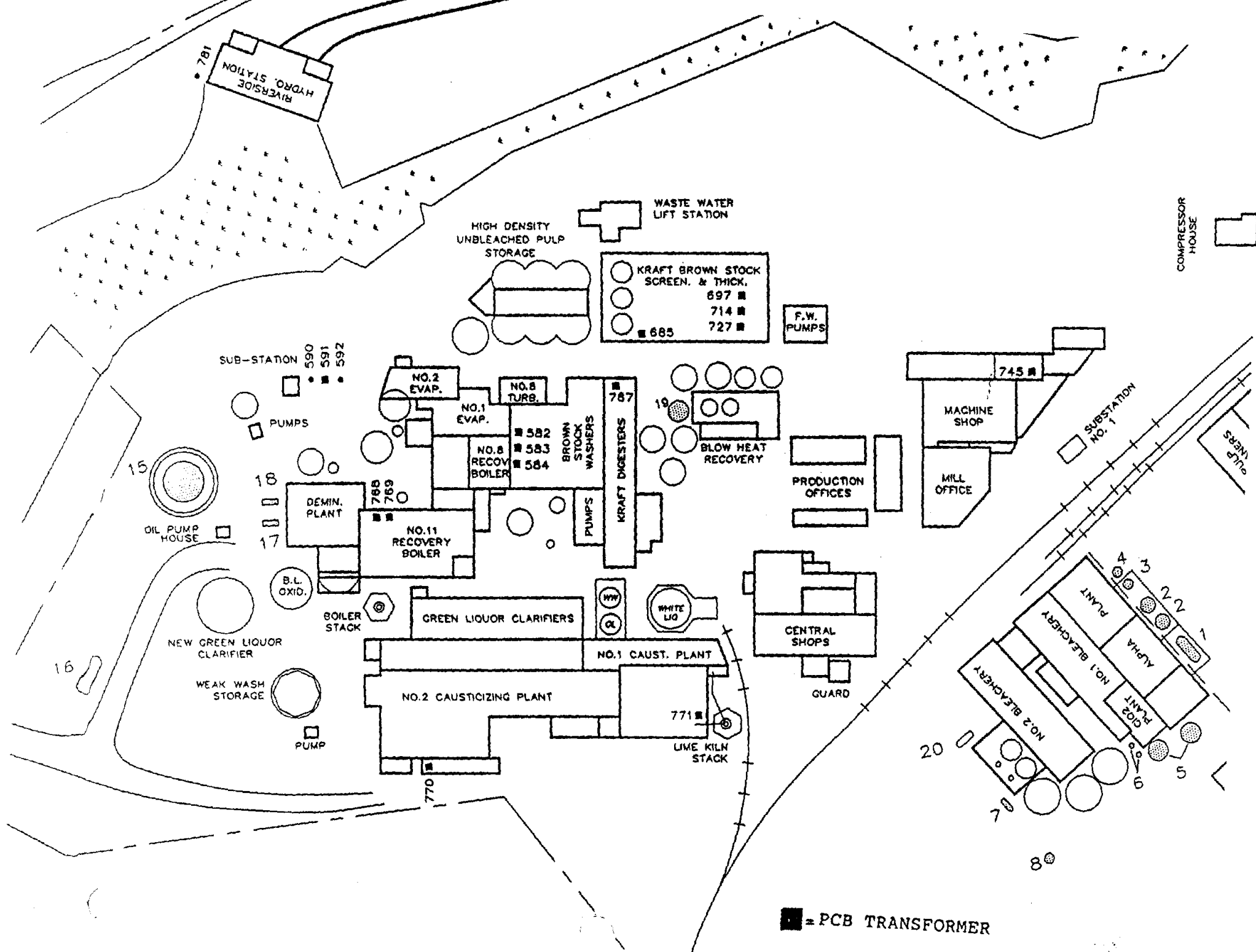
2. RPF has relied upon the data provided to the extent indicated and has not conducted an independent evaluation of the reliability of the PPA Inventory data. Based on our preliminary visual observations, it appears that other suspect ACM are present that are not addressed in the PPA Inventory. These other suspect ACM will require inspection, testing and documentation in accordance with the most current State and federal regulations prior to any renovation and demolition activity in the affected areas. Based on the results of such further survey work, the preliminary cost estimates for abatement and surface cleaning could be significantly impacted.
3. Observations were made of the designated areas of the site as indicated in the Preliminary Letter of Findings. While it was the intent of RPF to conduct a survey to the degree indicated, it is important to note that not all ACM in the designated areas were specifically assessed and visibility was limited, as indicated, due to the presence of solid walls and ceilings and mechanical systems such as the large boiler units throughout the facility. Asbestos may have been used and may be present in areas where detection and assessment is difficult or not possible until spot demolition is performed allowing access to such remote areas. Where access to portions of the surveyed area was unavailable or limited, RPF renders no opinion of the condition, assessment, and potential impact on remediation cost estimates.
4. Existing reports, drawings, and analytical results provided by the Client to RPF, as applicable, were not verified and, as such, RPF has relied upon the data provided as indicated, and has not conducted an independent evaluation of the reliability of these data. Prior to construction (during project design investigation) further testing and survey work, as well as more detailed reviews of the existing records should be performed by qualified, licensed firms.

DRAFT

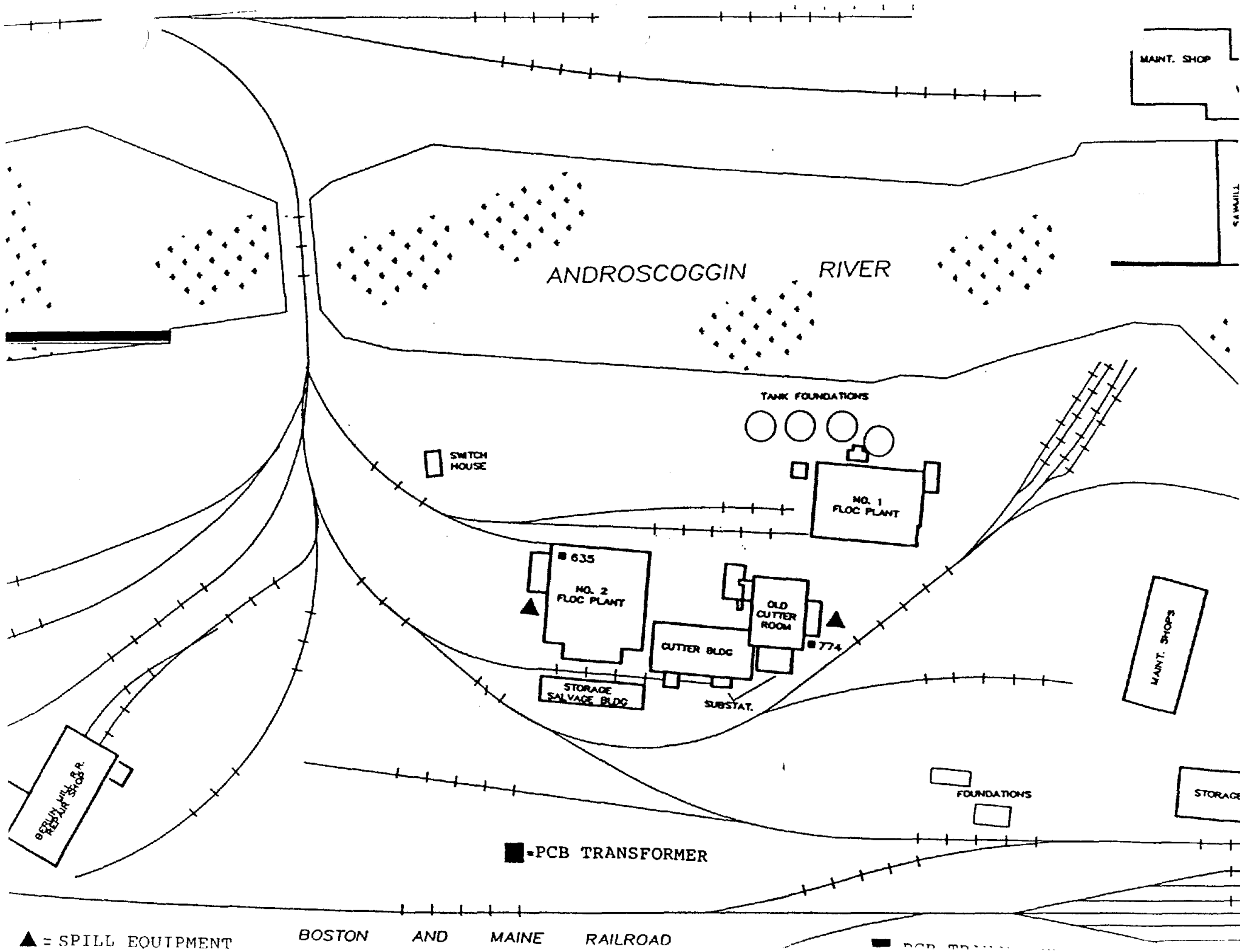
PCB Transformer Locations from the Gorham Fire Department

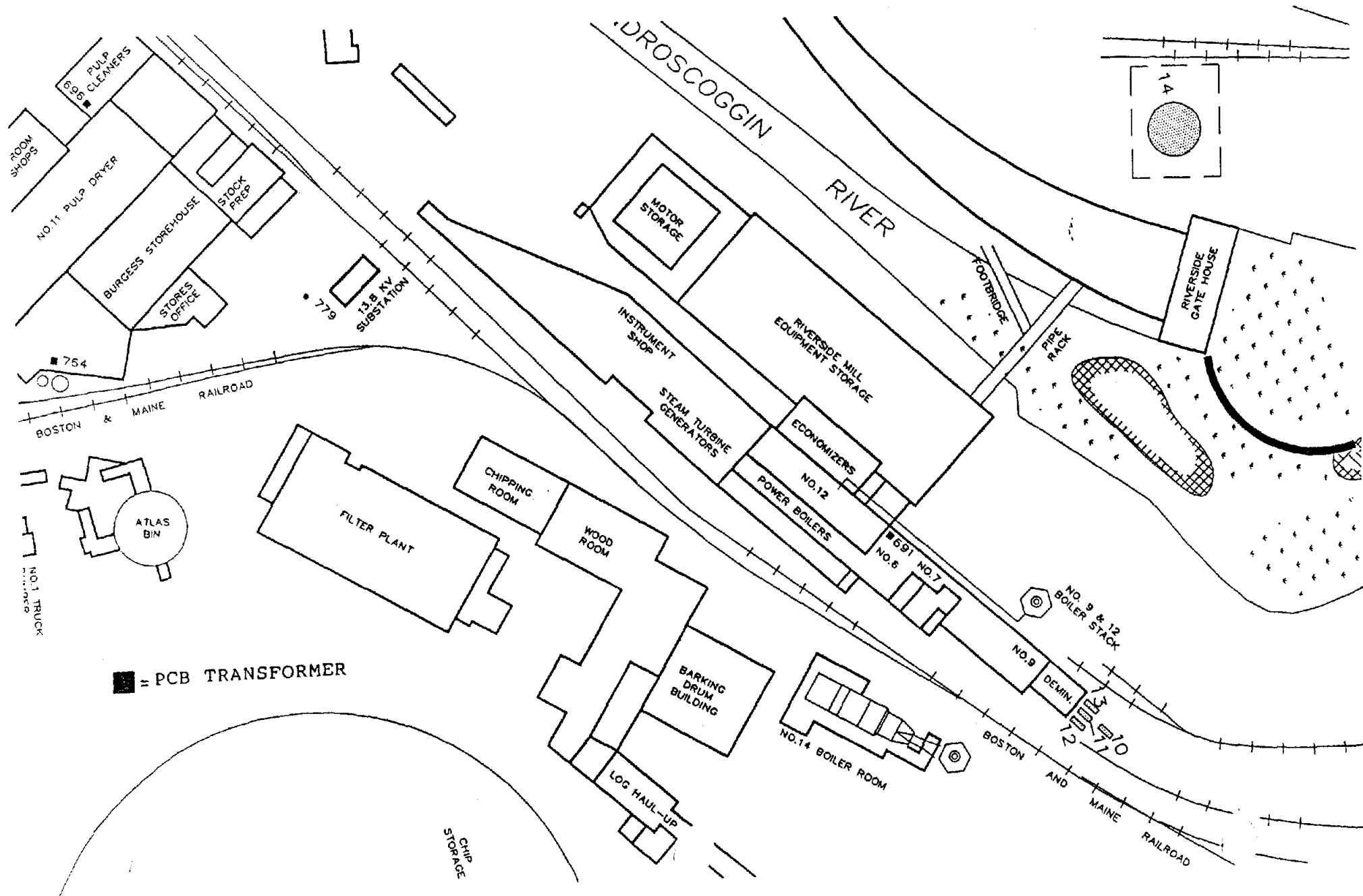
September 2006





■ = PCB TRANSFORMER





- 000001

**NH DES WASTE MANAGEMENT DIVISION
ENVIRONMENTAL INCIDENT RESPONSE REPORT**

Date Received:
3/14/2005

Time Received: 1535
hrs

Incident # HWI 05-006
Received by: CFWoodbury

Reporter Name: State Police Dispatch
Reporter Title:

Phone: 271-3636

Facility Name: Fraser Paperl

Facility Address/Location:

Berlin

Zip code

Phone Number at incident:

EPA Identification Number:

Incident date: 3/12/2005

Incident time: 1500 hrs

Incident type: Transportation Accident

train car derailment

Material(s): unknown

Quantity: unknown

Injuries: None

Description: 9 Hazmat train car derailed. No release

Evacuations: None

Comments:

Human Health/Environmental Hazards:

Additional Information:

Directions to the site:

Responsible Party (name, address, phone, contact person): Fraser Paper / St. Lawrence + Atlantic RR

Affected Area: Land Only

Surface Water (name):

Fire Department notified: Yes

Agencies/ Officials on scene:

Clean-up contractor hired: No

Time notified:

Name of Clean-up contractor:

Response action taken:

Division response: Notification

STATE OF NEW HAMPSHIRE

Inter-Department Communication

DATE: June 20, 2002

FROM: Margaret Bastien, P.E. *MAB 6/20/02*

AT (OFFICE): NHDES-WMD

SUBJECT: BERLIN – Site Visit to Berlin Pulp Mill and Gorham Paper Mill on May 28, 2002: (DES# 199709046)

TO: File

Doug Laughton and Margaret Bastien toured the Berlin Pulp Mill and the Gorham Paper Mill on May 28, 2002. Tammie Lavoie of Pulp and Paper of America accompanied us. The purpose of this tour was to identify any environmental issues that have arisen due to the plants' shutdown.

Berlin Pulp Mill

Summary of Observations

There were numerous areas through out the Berlin Pulp Mill buildings where drums of lubrication oil and waste oil were stored. Some of the drums appeared to contain product. Of the areas observed, all except for the area labeled Tank B03 were on concrete floor. Staining of concrete flooring was observed at many of these oil storage areas. In area Tank B03, dirt beneath one of the drums was stained. In areas Tank B11 and Tank C11, free product beneath the drums was observed on the concrete floor. In area Tank B11, free product was observed beneath a drum labeled as containing waste oil. In area Tank C11, free product was observed beneath a drum labeled as containing lubrication oil. In the Boiler House 9 and 12, the drum storage area was adjacent to a floor drain. Some minor staining of the concrete floor was observed. However, no sheens were observed on the water in the floor drain.

A light sheen was observed on standing water in the bermed area for the No.6 fuel oil above ground storage tank CRU No. 6. There was staining on the asphalt surfaces within the bermed area.

Gorham Paper Mill

Summary of Observations

Product was observed in the bermed area for the No. 6 fuel oil above ground storage tank. According to Tammie Lavoie, a spill occurred in August 2001. The majority of the spilled product was removed.

Numerous drum storage areas were observed through out the facility. These areas were on concrete floor. Staining of the concrete floor was observed at many of these areas. Absorbent

pads were observed in the storage area labeled Tank CO7. Free product was observed on the concrete floor around a lubrication oil drum in storage area Tank C11. A large storage area was present along the southern wall of the maintenance shop. Product was observed on the asphalt around a 330-gallon plastic tank that was labeled as containing lubrication oil. No cracks were observed in the asphalt.

Comments and Recommendations

No conditions were observed that would indicate that a significant release of hazardous material or petroleum products has occurred recently. The issues I observed were what I would classify as housekeeping issues and should be addressed.

**SITE INVESTIGATION REPORT
FORMER CHLOR-ALKALI FACILITY
BELOW SAW MILL DAM
BERLIN, NEW HAMPSHIRE
DES SITE #199709046**

Prepared for:

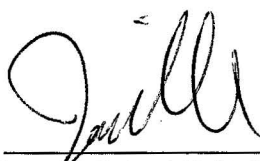
NEW HAMPSHIRE DEPARTMENT OF ENVIRONMENTAL SERVICES

29 Hazen Drive
P.O. Box 95
Concord, New Hampshire 03302-0095

Prepared by:


WESTON SOLUTIONS, INC.

One Wall Street
Manchester, New Hampshire 03101-1501



Joseph Schmidl, P.G.
Project Manager

2/11/05
Date



For

Arthur J. Cunningham, P.E.
Program Manager

2/11/05
Date

10 February 2005

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EXECUTIVE SUMMARY

On behalf of the New Hampshire Department of Environmental Services (NHDES), Weston Solutions, Inc. (WESTON®) has prepared this Site Investigation Report for the Former Chlor-Alkali Facility ("the Site"), located below the Sawmill Dam in Berlin, New Hampshire (DES #199709046). In 1999, it was discovered that elemental mercury dense, non-aqueous phase liquid (DNAPL) was visible in bedrock fractures exposed in outcrops along the banks of the Androscoggin River adjacent to the Site. Despite removal actions taken to date, elemental mercury is still evident. This investigation was conducted to evaluate source distribution and migration pathway(s) of elemental mercury DNAPL and other contaminants present in groundwater beneath the Site.

The Site was operated as a chlor-alkali facility, which manufactured chlorine gas and sodium hydroxide for use in paper manufacturing, from the late 19th Century until about 1950. The mercury cell process was used at the facility. This process used large quantities of elemental mercury as the cathode in an electrolytic process. It is presumed that elemental mercury was routinely released from the facility during operation of the mercury cells. In 1999, the Cell Houses at the Site were demolished, and an impermeable cap and slurry wall were constructed in an effort to hydrologically isolate the Site from its surroundings. Previous investigative activities at the Site by NHDES and others have included the collection of surface water and sediment samples from the adjacent Androscoggin River; detailed mapping of exposed bedrock fractures; advancement of soil borings; installation of overburden and shallow bedrock monitoring wells; and the collection and analysis of soil, groundwater, and residential drinking water samples. The analytical results of groundwater samples previously collected from the Site revealed the presence of volatile organic compounds (VOCs) at concentrations as high as 0.351 milligrams per liter (mg/L), and lead at concentrations as high as 0.082 mg/L. The highest concentration of mercury detected prior to spring 2004 in a groundwater sample was 0.110 mg/L. This result was associated with a sample collected in August 1999 from the shallow bedrock monitoring well MW-8, which is located in the western portion of the Site. Historically, 17 wells have been found to contain mercury, lead, VOCs or semi-volatile organic compounds (SVOCs) at concentrations that exceeded their respective NHDES Ambient Groundwater Quality

Standards (AGQs) on one or more occasions. In addition, since 1999, the Site owner or NHDES has annually recovered elemental mercury from bedrock fractures and shallow sediments adjacent to and downgradient of the Site, with approximately 55 to 105 pounds of mercury recovered during six recovery efforts. In addition, a dark-colored tar-like material that appears to have flowed to its current location was discovered adjacent to the bank of the Androscoggin River south of the landfill.

In October 2003, NHDES requested that WESTON continue the investigation to further assess the nature and extent of contamination at the Site. The subsequent investigation included a walkover of the Site; the advancement of 19 soil borings; the installation, development, and surveying of nine overburden monitoring wells, seven shallow bedrock monitoring wells, and three deep bedrock monitoring wells; the collection and analysis of soil and groundwater samples; and hydrogeologic testing of the overburden and bedrock monitoring well network. These activities were conducted by WESTON between February and April 2004. Field screening and analytical results of subsurface soil samples collected during the soil boring program indicate the presence of mercury at concentrations above applicable NHDES Method 1 S-3 standards. Six soil borings, advanced south of the landfill, did not identify a subsurface source of the dark tar-like material observed along the bank of the Androscoggin River, farther south of the landfill. However, soil analytical results from these soil borings documented surficial soil concentrations of benzo(a)pyrene and arsenic that exceed NHDES Method 1 S-3 standards.

The analytical results of groundwater samples collected by WESTON from on-site monitoring wells in spring 2004 indicate the presence of mercury at concentrations between 0.00023 and 0.330 mg/L and lead at concentrations between 0.005 and 1.0 mg/L. During the most recent round of groundwater sampling in April 2004, three VOCs, one SVOC, and six metals were also detected in one or more monitoring wells at concentrations above their NHDES AGQs, with a total of 13 of the 27 wells sampled having one or more exceedances. Of these, six wells contained mercury at concentrations that exceed the NHDES AGQS of 0.002 mg/L. The impacted groundwater is further characterized by high hydrogen ion concentration (up to 12.02) and specific conductance (up to 6,200 microseimens per centimeter). The highest mercury concentrations were observed in the vicinity of shallow bedrock monitoring wells MW-7 and MW-8. Strong correlations are noted between WESTON 2004 groundwater analytical results,

U.S. Geologic Survey 2003 geophysical surveys, WESTON 2004 shallow bedrock hydraulic conductivity measurements, and the occurrence of mercury seeps at the Site. The area west and southwest of monitoring wells MW-7 and MW-8 has elevated mercury concentrations in groundwater, electrical conductivity, hydraulic conductivity, and common observations of liquid and solid mercury deposits.

Overburden at the Site consists primarily of fill, much of which is demolition debris. The overburden ranges in thickness from 4 to 26 feet (ft). A discontinuous, thin layer of glacial till overlies the bedrock in some areas and contains frequent cobbles. The underlying bedrock consists of plutonic rocks of the Oliverian Plutonic Suite, which is described as biotite quartz monzonite gneiss. The gneiss is typically fractured, and contains discontinuous inclusions of pegmatite and chlorite schist that interrupt the bedrock fractures. The water table is approximately 4 to 17 ft below ground surface. U.S. Geologic Survey detailed bedrock mapping shows that the bedrock beneath the Site is primarily gneiss, containing sub-horizontal, tabular pegmatites and discontinuous lenses of chlorite schist. Steeply-dipping fractures within the gneiss tend to truncate on the relatively unfractured pegmatites and chlorite schist lenses. These features control fracture interconnection and groundwater flow direction.

WESTON hydraulic conductivity testing indicates that overburden hydraulic conductivity is generally one to three orders of magnitude greater than in the underlying shallow bedrock. A zone of elevated hydraulic conductivity in shallow bedrock crosses the Site, trending northwestward between shallow bedrock monitoring wells MW-20B and MW-7. Bedrock well interconnectivity testing performed by WESTON indicates that a few well pairs are interconnected, but that the majority of bedrock fractures are discontinuous at the scale of the Site. Bedrock fracture interconnectivity results in the fracture zone interpreted in the vicinity of well MW-7 were inconclusive due to interference by river fluctuations.

WESTON groundwater elevation and vertical hydraulic gradient calculations indicate that the slurry wall located along the eastern edge of the landfill is only a partial barrier to lateral groundwater flow through overburden. Available vertical hydraulic gradient data suggest that the slurry wall is subject to through-flow, rather than under-flow.

WESTON 2004 groundwater analytical results indicate that mercury DNAPL is likely present in shallow bedrock in the vicinity of monitoring well MW-8. This mercury DNAPL may be perched on top of pegmatite bodies at this location. This indication of mercury DNAPL is consistent with the observation of elemental mercury deposits west and southwest of monitoring well MW-8.

Three distinct mercury transport mechanisms may contribute in part to the observed elemental mercury deposits in the river. Mercury DNAPL may be discharging to the surface by gravity flow, with or without the assistance of hydraulic head. Elemental mercury vapor may be released from groundwater into bedrock fractures, and then redeposited at the openings of the fractures. Soluble mercury (zero-valent and/or divalent) may be transported via groundwater and rendered insoluble upon mixing with river water in the hyporheic zone, resulting in deposition of mercury.

2. SITE DESCRIPTION AND HISTORY

The Site is an approximately 4.6-acre parcel located off Hutchins Street in Berlin, Coos County, New Hampshire (Figure 2-1). According to property cards at the Town of Berlin Assessor's office, the Site is located in an industrially-zoned area and is identified as Lot 54 on Berlin Tax Map Number 128 (Tighe & Bond (T&B), 2001). The Site is an inactive industrial property and comprises a landfill containing demolition debris from the former chlor-alkali cell houses. It is bounded by industrial property owned by Fraser Paper to the north, east, and south, and is bounded by the Androscoggin River to the west. A penstock that serves as the main water source for the paper mill to the south is located immediately east of the Site. The Site is gently sloping with the high spot located near the center of the Site.

The Site is registered by NHDES as a current Resource Conservation and Recovery Act (RCRA) hazardous waste generator (U.S. Environmental Protection Agency (EPA) ID #NHD510177173). A review of the manifests listed under this ID indicates that the waste stream was limited to mercury recovered from the Site between 2002 and 2003 (NHDES, 2004). The Site is also listed as an NHDES Hazardous Waste Site (NHDES ID #199709046) (NHDES, 2004).

According to information obtained during a review of NHDES files, the property has been part of a paper manufacturing plant since at least 1850. From the late 19th Century until the early 1950s, the Site was the location of a chemical plant that produced materials for use at the paper plant (Sevee & Maher Engineers, Inc. (SME), 1999a). The size of the chemical plant grew to approximately 200,000 square feet by 1920 (T&B, 2001). The largest component of the chemical plant was the chlor-alkali facility, which used graphite-mercury cells to manufacture chlorine gas and sodium hydroxide for use in paper manufacturing. The chlor-alkali facility included lime and liquor tanks, a hydrogen gasometer, chlorine gas cell houses, a transformer house, an absorption building, evaporator building, a caustic plant, caustic shed, and chloroform still rooms (Black, O. P., 1919). Some of the chemical plant buildings were removed between 1928 and 1950 (T&B, 2001).

In 1999, the last of the cell houses at the Site were demolished, and an impermeable cap and slurry wall were constructed (Figure 2-2). The chemical plant building demolition materials were used as fill material during the capping project (T&B, 2001). Apparently, in some areas, clean sand was applied to the top of the demolition debris prior to the installation of the landfill cover, likely to separate the liner from sharp pieces of demolition debris. The landfill is capped with a 60-mil high-density polyethylene (HDPE) cover, which is overlain by up to 3 feet (ft) of wood chips. A slurry wall was constructed along the southeastern boundary of the landfill in an effort to reduce groundwater through-flow. A concrete retaining wall is located along the majority of the western side of the landfill that separates the landfill from the adjacent Androscoggin River. Water seeps have been noted at the base of the retaining wall and from pipes that pierce the wall.

The first investigations of the Site were conducted between April and July 1999 by T&B for Pulp & Paper of America. The investigations, a *Limited Environmental Assessment* (T&B, 1999a) followed by a *Soil Delineation Project*, included surficial and subsurface soil sampling, sediment sampling of the Androscoggin River, installation and sampling of six overburden (MW-1 to MW-6), and three shallow bedrock monitoring wells (MW-7 to MW-9) (T&B, 2001). In addition, surficial and subsurface soil samples were collected and analyzed for lead and mercury, with selected samples analyzed for VOCs, SVOCs, total petroleum hydrocarbons, (TPH), and or polychlorinated biphenyls (PCB). The results of the investigation indicated that surface and subsurface soils throughout the Site contained lead and mercury in excess of NHDES Risk Characterization Management Policy (RCMP) standards. Concentrations of lead ranged up to 8,500 milligrams per kilogram (mg/kg) and concentrations of mercury ranged up 9,400 mg/kg. Concentrations of total VOCs ranged up to 0.351 mg/kg, concentrations of total SVOCs ranged up to 125 mg/kg, concentrations of TPH ranged up to 4,900 mg/kg, and concentrations of total PCBs ranged up to 16 mg/kg (T&B, 1999b). Groundwater sample analytical results indicated that mercury was present in groundwater beneath parts of the Site in excess of the NHDES AGQS of 0.002 mg/L, at concentrations up to 0.0028 mg/L. In addition, chloroform was detected at a concentration above the AGQS at one monitoring well (T&B, 2001).



In August 1999, a review of the existing data, the installation of one additional overburden (MW-10B) and two additional shallow bedrock (MW-4A and MW-10A) monitoring wells, and groundwater sampling were performed at the Site by SME for Crown Vantage. Based on the available data in August 1999 SME produced a *Conceptual Design Report* (SME, 1999a) and in November 1999 SME produced a *Closure Plan* (SME, 1999b) for the Site, both for Crown Vantage. Additional groundwater sampling was performed by SME in March and June 2000. The SME groundwater data indicated that concentrations of lead ranged up to 82 micrograms per liter ($\mu\text{g/L}$) and mercury concentrations ranged up to 110 $\mu\text{g/L}$. In addition, five VOCs were detected above their AGQS in two monitoring wells, and arsenic was detected above its AGQS in one well (SME, 2000b; T&B, 2001).

In November 1999, and March and June 2000, two retaining wall discharge pipes, a 3-inch-diameter pipe identified as DP-1 and an 8-inch-diameter pipe identified as DP-2, were sampled by SME for Crown Vantage. Groundwater discharging from DP-1 has been found to contain mercury at up to 85 $\mu\text{g/L}$, as well as the metals arsenic, barium, lead, and VOCs acetone, chloroform, naphthalene, tetrahydrofuran, hexachlorobutadiene, and chlorinated solvents. Groundwater discharging from DP-2 has been found to contain mercury at up to 8.7 $\mu\text{g/L}$, as well as the metals arsenic, barium, lead, and VOCs acetone, chloroform, methylene chloride, methyl ethyl ketone, p-isopropyltoluene, tetrahydrofuran, and chlorinated solvents. Surface water samples were also collected from the Androscoggin River in the vicinity of the retaining wall discharge pipes by SME in March and June 1999. No mercury, lead, or VOCs were detected in the surface water samples (T&B, 2001). There are no records that sediment samples have ever been collected from the canal to the east of the Former Chlor-Alkali Facility.

In January 2000, SME described the demolition of the final structures at the Site and the construction of the landfill in a *Closure Construction Report* (SME, 2000a).

In April 2001, T&B performed additional groundwater sampling at the Site. Groundwater analytical results were consistent with previous findings. The available groundwater analytical results were summarized in a submittal made to NHDES titled *Application for Groundwater Management*, prepared for Pulp & Paper of America (T&B, 2001). (Note: NHDES did not issue a groundwater management permit.)

2-4

During 2002 and 2003, U.S. Geologic Survey (USGS) personnel performed investigative activities at the Site at the request of NHDES. The USGS investigation included the following focus areas: detailed mapping of bedrock geology, geophysical surveying using ground-penetrating radar and electrical resistivity techniques, and long-term monitoring of groundwater and surface water elevations (USGS, 2004).

In addition to the investigations described above, remedial actions have been undertaken to address elemental mercury that has been noted along the bank of the Androscoggin River adjacent to the Site's western boundary. Mercury has been discovered in pools above bedrock crevices in the river bottom, droplets and balls at the openings of bedrock fractures, and disseminated as fine droplets within sand and gravel deposits along the river (SME, 2000a). Annual removals of elemental mercury have been conducted since 1999, with the first recovering the most mercury, approximately 50 to 100 pounds (SME, 2000a). WESTON, under contract to NHDES, performed detailed mercury discharge mapping of the bedrock outcrops along the bank of the Androscoggin River in June and October, 2003. Later removal efforts focused on fresh accumulations of mercury in the locations previously cleaned and have annually recovered approximately 1 pound of mercury (WESTON, 2004).

Table 3-1
Summary of Soil Borings/Monitoring Wells

Monitoring Well ID	Rationale
MW-11A/B	Overburden/shallow bedrock well couplet located in the southeast corner of the capped area, to evaluate groundwater flow in the vicinity of a high-conductivity geophysical anomaly (possibly a former water main) and the integrity of the slurry wall, in conjunction with well MW-12.
MW-12	Overburden well located outside the southeast corner of the capped area, to evaluate groundwater flow in the vicinity of a high-conductivity geophysical anomaly (possibly a former water main) and the integrity of the slurry wall, in conjunction with wells MW-11A/B.
MW-13A/B	Overburden/shallow bedrock well couplet located along the northwestern boundary of the capped area (near piezometer P-13), to evaluate groundwater flow in the vicinity of a high-conductivity geophysical anomaly and a low area in the bedrock surface.
MW-14	Deep bedrock well located along the western boundary of the capped area (near wells MW-2 and MW-7), to evaluate groundwater flow in the vicinity of a low area in the bedrock surface.
MW-15	Deep bedrock well located along the western boundary of the capped area (near piezometer P-15), to evaluate groundwater flow in the vicinity of a high-conductivity geophysical anomaly.
MW-16A/B	Overburden/shallow bedrock well couplet located outside the southwest corner of the capped area near the western end of the slurry wall, to evaluate groundwater flow in the vicinity of a high-conductivity geophysical anomaly, a suspected low area of the bedrock surface, and the integrity of the slurry wall in the vicinity.
MW-17	Overburden well located in the northern corner of the capped area, to evaluate groundwater flow in the vicinity.
MW-18A/B	Overburden/shallow bedrock well couplet located outside the eastern boundary of the capped area to evaluate groundwater flow in the vicinity.
MW-19	Shallow bedrock well located near the eastern boundary of the capped area, to evaluate groundwater flow in the vicinity of a high-conductivity geophysical anomaly.
MW-20A/B	Overburden/shallow bedrock well couplet located within the eastern boundary of the capped area (near piezometer P-20), to evaluate groundwater flow in the vicinity of a high-conductivity geophysical anomaly and the integrity of the slurry wall, in conjunction with well MW-22.
MW-21	Deep bedrock well located near the southern boundary of the capped area (near wells MW-5 and MW-9), to evaluate groundwater flow in the vicinity.
MW-22	Overburden well located in the northern corner of the capped area (near piezometer P-20), to evaluate groundwater flow in the vicinity of a high-conductivity geophysical anomaly and the integrity of the slurry wall, in conjunction with wells MW-20A/B.
MW-23A/B	Overburden/shallow bedrock well couplet located outside the eastern boundary of the capped area, to evaluate groundwater flow in the vicinity of a low area in the bedrock surface.
SB-01 to SB-06	Six overburden soil borings advanced southwest of the landfill upgradient of an area where a tar-like substance has been noted along the riverbank, to investigate the possible source of the material.

Table 3-2
Summary of Overburden Soil Boring Characteristics

Soil Boring ID	Overburden Thickness (ft)	Depth of Bedrock Coring (ft)	Maximum VOC Soil Headspace ¹	Maximum Mercury Soil Headspace ²
MW-11A	25.5	n/a	BKG	BKG
MW-11B	25.0	53.7	BKG	BKG
MW-12	18.4	n/a	BKG	BKG
MW-13A	26.0	n/a	BKG	BKG
MW-13B	25.0	40.0	BKG	BKG
MW-14	10.5	63.9	BKG	0.023 mg/m ³
MW-14R	10.0	49.0	BKG	BKG
MW-15	15.5	53.5	BKG	0.034 mg/m ³
MW-16A	10.0	n/a	BKG	BKG
MW-16B	10.0	n/a	BKG	BKG
MW-17	17.5	n/a	BKG	BKG
MW-18A	18.0	n/a	BKG	BKG
MW-18B	20.0	43.5	BKG	0.046 mg/m ³
MW-19	19.0	43.2	BKG	BKG
MW-20A	12.0	n/a	BKG	No hits
MW-20B	12.0	35.15	BKG	BKG
MW-21	8.0	50.0	BKG	BKG
MW-22	18.5	n/a	BKG	BKG
MW-23A	20.0	n/a	BKG	BKG
MW-23B	21.0	53.7	BKG	BKG
SB-01	5.5	n/a	BKG	BKG
SB-02	4.0	n/a	BKG	BKG
SB-03	4.0	n/a	BKG	BKG
SB-04	9.0	n/a	BKG	BKG
SB-05	4.0	n/a	BKG	BKG
SB-06	5.0	n/a	BKG	BKG

Notes: ¹ = Subsurface materials were screened with an organic vapor monitor 580B photoionization detector equipped with a 10.6 electron volt (eV) lamp.

² = Subsurface materials were screened with a Jerome Mercury Vapor Monitor.

BKG = No screening results above background concentrations were noted.

n/a = not applicable

ft = feet

mg/m³ = milligrams per cubic meter

VOC = volatile organic compound

Table 3-3**Summary of Soil Samples Relinquished to START**

Soil Boring Location	START Sample ID	Date Collected	Sample Depth Interval (ft bgs)	Comments
MW-11A	SO-01	3/3/04	3.0-3.5	
MW-11A	SO-02	3/3/04	24.0-25.5	
MW-13A	SO-03	3/1/04	1.5-6.0	
MW-17	SO-04	3/4/04	12.0-16.0	Duplicate with SO-08
MW-13A	SO-05	3/2/04	23.0-25.0	
MW-16A	SO-06	3/3/04	0.0-2.0	
MW-16A	SO-07	3/3/04	8.0-10.0	
MW-17	SO-08	3/4/04	12.0-16.0	Duplicate with SO-04
MW-17	SO-09	3/4/04	16.0-17.5	
MW-21	SO-10	3/4/04	3.0-5.0	
MW-21	SO-11	3/4/04	6.0-8.0	
MW-22	SO-12	3/3/04	6.0-9.0	
MW-22	SO-13	3/3/04	15.0-18.5	
MW-12	SO-14	3/1/04	0.0-2.0	
MW-12	SO-15	3/2/04	15.0-18.4	
SB-01	SO-16	3/8/04	2.0-2.5	
SB-02	SO-17	3/8/04	0.0-2.0	Duplicate with SO-18
SB-02	SO-18	3/8/04	0.0-2.0	Duplicate with SO-17
SB-03	SO-19	3/8/04	0.0-2.0	
SB-04	SO-20	3/8/04	0.0-4.0	
SB-05	SO-21	3/8/04	0.0-2.0	
SB-06	SO-22	3/8/04	0.0-2.0	

ft bgs = feet below ground surface

Following drilling activities, the drums containing wastewater were discharged to the ground at the Site, per instructions from NHDES. The drums containing drilling spoils and any contaminated disposable equipment, personal protective equipment, or other IDW were stored at the Site according to federal and state regulations. The drums containing non-hazardous solid waste at the Site are awaiting removal, pending the completion of paperwork from NHDES.

temperatures, The Liner Company, a subcontractor specializing in maintenance of synthetic membranes, sealed the landfill HDPE cover around the well casing at each drilling location. Thirteen of the 19 wells installed by WESTON penetrated the HDPE cover and required this procedure.

Table 3-4
Summary of Monitoring Well Characteristics

Monitoring Well ID	Measuring Point Elevation (ft amsl)	Hydrologic Unit Screened	Screen/Borehole Depth Interval (ft bgs)	Groundwater Elevation ¹ (ft amsl)
MW-11A	1096.44	Overburden	15.5-25.5	1089.77
MW-11B	1096.14	Shallow Bedrock	29.0-53.7	1089.94
MW-12	1097.03	Overburden	8.0-18.0	1089.51
MW-13A	1095.90	Overburden	16.0-26.0	1085.70
MW-13B	1095.76	Shallow Bedrock	28.0-55.0	1084.46
MW-14R	1049.95	Deep Bedrock	44.0-49.0	1051.95
MW-15	1098.53	Deep Bedrock	25.0-35.0	1078.53
MW-16A	1093.27	Overburden	5.0-10.0	1085.37
MW-16B	1094.06	Shallow Bedrock	18.0-38.0	1084.20
MW-17	1105.00	Overburden	7.5-17.5	1088.55
MW-18A	1100.34	Overburden	8.0-18.0	1093.68
MW-18B	1100.31	Shallow Bedrock	23.4-43.4	1093.47
MW-19	1101.03	Shallow Bedrock	23.0-43.2	1091.51
MW-20A	1102.08	Overburden	7.0-12.0	1091.79
MW-20B	1102.67	Shallow Bedrock	15.0-35.15	1091.15
MW-21	1097.17	Deep Bedrock	35.0-45.0	1084.82
MW-22	1098.70	Overburden	8.5-18.5	1093.31
MW-23A	1105.84	Overburden	10.0-20.0	1089.04
MW-23B	1105.48	Shallow Bedrock	24.5-53.7	1090.83

Notes: ¹ = Water elevation data collected April 7 to 8, 2004.

amsl = above mean sea level

ft bgs = feet below ground surface

hydraulic conductivity values. Table 3-5 summarizes the results of WESTON's hydraulic conductivity testing.

Table 3-5

Summary of Hydraulic Conductivity Testing Results

Well ID	Test Date	Rising Head Hydraulic Conductivity (cm/s)	Falling Head Hydraulic Conductivity (cm/s)
MW-7	4/12/04		1.12×10^{-4}
MW-8	4/12/04		2.64×10^{-5}
MW-9	4/13/04		7.21×10^{-6}
MW-10A	4/13/04		5.32×10^{-5}
MW-11A	4/14/04	1.44×10^{-3}	
MW-11B	4/13/04		3.45×10^{-5}
MW-13A	4/16/04	9.84×10^{-4}	
MW-13B	4/12/04		7.24×10^{-6}
MW-14R	4/12/04		5.75×10^{-6}
MW-15	4/13/04		5.19×10^{-7}
MW-16A	4/14/04	1.90×10^{-3}	
MW-16B	1/13/04		9.62×10^{-6}
MW-17	4/16/04	2.64×10^{-3}	
MW-18B	4/12/04		3.32×10^{-4}
MW-20A	4/16/04	2.36×10^{-3}	
MW-20B	4/13/04		2.22×10^{-4}
MW-21	4/13/04		4.28×10^{-5}
MW-23A	4/16/04	1.22×10^{-3}	
MW-23B	4/12/04		4.66×10^{-5}

Notes: cm/s = centimeters per second

The results show that overburden hydraulic conductivity is higher than bedrock hydraulic conductivity, by one to three orders of magnitude. Overburden hydraulic conductivity ranges from 2.64×10^{-3} to 9.84×10^{-4} centimeters per second (cm/s), and varies only by a factor of approximately 2.7 across the Site, while bedrock hydraulic conductivity ranges from 3.32×10^{-4} to 5.19×10^{-7} cm/s, and varies by a factor of approximately 640. Shallow bedrock hydraulic

Table 3-6

Summary of Well Interconnectivity Testing Results

Well ID	Test Date	Wells with Apparent Interconnection (response, ft)	Wells with No Apparent Interconnection to the Test Well
MW-7	4/12/04	None	MW-8, MW-9, MW-13B, MW-15, MW-18B, MW-20B, MW-21, MW-23B
MW-8	4/12/04	None	MW-7, MW-9, MW-13B, MW-14R, MW-15, MW-18B, MW-20B, MW-21, MW-23B
MW-9	4/13/04	MW-10A (0.02)	MW-8, MW-11B, MW-14R, MW-16B, MW-18B, MW-20B, MW-23B
MW-10A	4/13/04	None	MW-8, MW-11B, MW-14R, MW-16B, MW-18B, MW-20B, MW-21
MW-11B	4/13/04	None	MW-8, MW-10A, MW-14R, MW-16B, MW-18B, MW-20B, MW-21
MW-13B	4/12/04	None	MW-7, MW-8, MW-9, MW-14R, MW-15, MW-18B, MW-21, MW-23B
MW-14R	4/12/04	MW-21 (0.03)	MW-7, MW-8, MW-9, MW-13B, MW-15, MW-18B, MW-20B, MW-23B
MW-15	4/13/04	None	MW-8, MW-10A, MW-13B, MW-14R, MW-18B, MW-20B, MW-21
MW-16B	1/13/04	None	MW-8, MW-10A, MW-18B, MW-20B, MW-21
MW-18B	4/12/04	None	MW-7, MW-8, MW-9, MW-13B, MW-14R, MW-15, MW-20B, MW-21
MW-20B	4/13/04	None	MW-8, MW-10A, MW-11B, MW-14R, MW-16B, MW-18B, MW-21
MW-21	4/13/04	None	MW-8, MW-10A, MW-11B, MW-14R, MW-16B, MW-18B
MW-23B	4/12/04	None	MW-7, MW-8, MW-9, MW-13B, MW-14R, MW-15, MW-18B, MW-20B, MW-21

ft = feet

Table 3-7**Summary of Groundwater Samples Collected from Monitoring Wells**

Well ID	Sample ID	Sample Date	Analytical Parameters
MW-2	MW2-0404	4/7/2004	VOCs, SVOCs, Metals
MW-4	MW4-0404	4/8/2004	Metals
MW-5	MW5-0404	4/7/2004	Metals
MW-7	MW7-0404	4/7/2004	VOCs, SVOCs, Metals
MW-8	MW8-0404	4/7/2004	Metals
MW-9	MW9-0404	4/7/2004	Metals
MW-10A	MW10A-0404	4/8/2004	Metals
MW-10B	MW10B-0404	4/8/2004	Metals
MW-11A	MW11A-0404	4/7/2004	Metals
MW-11B	MW11B-0404	4/7/2004	Metals
MW-12	MW12-0404	4/7/2004	Metals
MW-13A	MW13A-0404	4/7/2004	VOCs, SVOCs, Metals
MW-13B	MW13B-0404	4/7/2004	VOCs, SVOCs, Metals
MW-14R	MW14-0404	4/8/2004	VOCs, Metals
MW-15	MW15-0404	4/7/2004	Metals
MW-16A	MW16A-0404	4/7/2004	Metals
MW-16B	MW16B-0404	4/7/2004	Metals
MW-17	MW17-0404	4/8/2004	Metals
MW-18A	MW18A-0404	4/8/2004	Metals
MW-18B	MW18B-0404	4/8/2004	Metals
MW-19	MW19-0404	4/7/2004	Metals
MW-20A	MW20A-0404	4/7/2004	Metals
MW-20B	MW20B-0404	4/7/2004	Metals
MW-21	MW21-0404	4/7/2004	Metals
MW-22	MW22-0404	4/7/2004	Metals
MW-23A	MW23A-0404	4/8/2004	VOCs, SVOCs, Metals
MW-23B	MW23B-0404	4/8/2004	VOCs, SVOCs, Metals

SVOCs = semi-volatile organic compounds

VOCs = volatile organic compounds

Table 3-8

Summary of Groundwater Parameters Recorded from Monitoring Wells

Well ID	Temperature (°C)	Specific Conductance (μS/cm)	pH	Oxidation/Reduction Potential (mV)	Dissolved Oxygen (mg/L)	Turbidity (NTU)
MW-2	8.51	776	10.02	-133	0.51	9
MW-4	7.86	226	6.88	-74	0.21	2.1
MW-5	9.21	643	6.48	68	2.08	5
MW-7	8.48	2,604	11.43	-60	0.31	125
MW-8	10.69	6,042	11.86	-3.0	5.88 *	5.1
MW-9	10.36	2,600	6.35	-69	0.24	60
MW-10A	10.63	629	7.30	-156.0	0.19	6.8
MW-10B	11.40	2,634	10.58	57.5	0.45	13
MW-11A	9.48	310	6.09	43.0	0.22	26
MW-11B	9.39	2,475	9.29	10.3	4.34 *	29
MW-12	7.04	280	6.37	16.1	0.29	13
MW-13A	8.42	492	9.09	-168	0.16	9.1
MW-13B	8.43	2,900	12.02	-168	0.16	1.6
MW-14R	--	--	--	--	--	--
MW-15	8.76	1,806	11.89	-19.6	7.00 *	5
MW-16A	8.45	548	7.16	-46	0.23	7
MW-16B	9.18	3,854	11.94	-6.8	0.18	8
MW-17	4.36	178	7.93	-144	0.21	2.2
MW-18A	6.76	374	6.43	-46.0	0.20	26
MW-18B	6.82	1,298	11.55	-207.8	0.15	4.3
MW-19	9.23	298	7.26	-159.3	0.22	21
MW-20A	8.20	2,746	9.46	-328.1	0.07	--
MW-20B	8.83	4,566	11.90	-92.0	0.11	25
MW-21	10.90	4,461	11.91	-149	0.11	26
MW-22	5.73	739	7.24	-177.5	0.16	0.20
MW-23A	6.95	308	6.51	24.8	1.42	3.6
MW-23B	7.30	240	8.22	-142	0.12	24

Note: °C = degrees centigrade
 μS/cm = microSiemens per centimeter
 mV = millivolt
 NTU = nephelometric turbidity unit

* = Dissolved Oxygen value is suspect.
 The Oxidation/Reduction Potential is considered
 to be more representative of conditions.

4. LABORATORY ANALYTICAL RESULTS

4.1 SOIL ANALYTICAL RESULTS

The analytical results for the soil samples collected from soil borings at the Site in February and March 2004 are included in Appendix G. The results are generally consistent with data collected during previous investigations at the Site.

The soil analytical results were validated according to EPA Tier II criteria, which identified a number of issues concerning the data. The VOC analytical data validation qualified acetone analytical results, based on the detection of acetone in the equipment rinsate blank sample. In addition, the VOC analytical results for some analytes were rejected due to preservation or holding time issues (START, 2004a). The SVOC and pesticide/PCB analytical data validations rejected a number of analytical results due to four separate laboratory issues (START, 2004b, 2004c, and 2004d). In addition, due to interference from other SVOCs detected in the samples, the detection limits for up to five SVOCs (atrazine, 2-chlorophenol, 2,4-dichlorophenol, naphthalene, and pentachlorophenol) were elevated above their NHDES Method 1 S-3 Soil Standards in some or all of the soil samples. The validation of the dioxin/furan and monomethyl mercury analytical results identified only a few minor issues that led to the estimation of a small number of analytical results (Lockheed, 2004; START, 2004e). The TAL Metals analytical data validations rejected selected antimony, cadmium, and selenium analytical results due to significant interference from other materials present in the sample (START, 2004f, 2004g, 2004h, and 2004i). The asbestos analytical results were not subject to validation (EPA, Office of Environmental Measurement & Evaluation, 2004). The data validation packages are also included in Appendix G.

Tables G-1 through G-5, in Appendix G, summarizes the hazardous substances detected in the soil samples. Tables G-1 through G-5 also lists the NHDES Method 1 S-3 Soil Standard for each detected analyte (NHDES, 2001). A summary of the hazardous substances detected above their NHDES Risk RCMP Method 1 S-3 Soil Standard in the soil samples is presented in Table 4-1.

Table 4-1

**Summary of Hazardous Substances Detected in Soil at Concentrations Exceeding
NHDES Method 1 S-3 Soil Standards**

Sample ID	Substance	Concentration mg/kg (except as noted)	NHDES RCMP S-3 Soil Standard ¹ mg/kg (except as noted)
SO-01	Beryllium	3	1
SO-03	Benzo(a)pyrene	25	4
	Dibenzo(a,h)anthracene	7.3	4
	2,3,7,8-TCDD TEQ ²	7,400 J	300
SO-08	Atrazine	0.29 J	0.08
SO-10	Arsenic	39.5 J	11
	Benzo(a)pyrene	13	4
	2,3,7,8-TCDD TEQ ²	1,300 J	300
SO-11	Arsenic	35.6 J	11
	Benzo(a)pyrene	13	4
	2,3,7,8-TCDD TEQ ²	1,300 J	300
SO-12	Arsenic	17.5 J	11
SO-16	Arsenic	18.1 J	11
SO-17	Arsenic	32.0 J	11
SO-18	Arsenic	25.8 J	11
SO-19	Arsenic	25.4 J	11
	Benzo(a)pyrene	6.8	4
SO-20	Arsenic	17.4 J	11
	Benzo(a)pyrene	6.6	4
SO-21	Arsenic	39.7 J	11
	Benzo(a)pyrene	4.9	4
SO-22	Arsenic	29.5 J	11
	Benzo(a)pyrene	5.3	4

Notes: ¹ = NHDES Risk Characterization and Management Policy (Section 7.5(2) and Appendix E, revised 4/27/04).

² = The standard shown is for 2,3,7,8-TCDD (Dioxin) in parts per trillion. The concentration reported is the TCDD Toxicity Equivalency Quotient in parts per trillion.

NHDES= New Hampshire Department of Environmental Services

mg/kg = milligrams per kilogram

J = Result estimated.

The soil analytical results are generally consistent with previous soil analytical results from the Site. The soil analytical results show that soil within the landfill is heterogeneous, with a wide range of contaminants and concentrations. Dioxin/furan exceedances in soil beneath the Site are

located within the landfill, beneath the cover material. The dioxin/furan exceedances are the result of elevated concentrations of furans, not dioxins. Furans are known to be associated with chlor-alkali processes, presumed to be produced by the chlorination of organic matter contained in the insulators of chlor-alkali cells (Turner, 2004).

These soil analytical results further identify surficial soils south of the landfill that exceed the NHDES Method 1 S-3 Soil Standards for arsenic and benzo(a)pyrene. Descriptions of the soils encountered south of the landfill indicated the presence of black staining. Benzo(a)pyrene is a typical constituent of coal and petroleum products that are typical sources of black staining in industrial soils. Arsenic is a common component of the granitic bedrock prevalent in the area, and may be naturally-occurring.

4.2 GROUNDWATER ANALYTICAL RESULTS

The laboratory analytical results of the groundwater samples collected in April 2004 are included in Appendix H. Tables H-1 through H-3, in Appendix H, summarize the VOCs, SVOCs, and metals detected in the groundwater samples, respectively. Tables H-1 through H-3 also lists the NHDES AGQS for each detected compound or analyte (NHDES, 2000). Table 4-2 further summarizes the groundwater analytical results, listing only the hazardous substances that exceed their NHDES AGQS.

The groundwater analytical results are generally consistent with previous groundwater analytical results from the Site, albeit elevated relative to previous data. The highest concentrations of VOCs detected were in overburden and shallow bedrock wells located along the downgradient (western) boundary of the Site, similar to previous findings. Comparison of the chlorinated VOC [tetrachloroethylene (PCE), trichloroethylene (TCE), and Vinyl Chloride (VC)] results for overburden monitoring well MW-13A and nearby shallow bedrock monitoring well MW-7 shows that the ratio of daughter product (VC) to parent products (PCE and TCE) is greater in the overburden groundwater sample than in the shallow bedrock groundwater sample. This suggests that shallow bedrock in the vicinity of MW-7 is closer to a source of chlorinated VOCs than overburden in the vicinity of MW-13A, where they appear to be more weathered.

Table 4-2

Summary of Hazardous Substances Detected in Groundwater at Concentrations Exceeding NHDES Ambient Groundwater Quality Standards

Sample ID	Substance	Concentration	NHDES AGQS ¹
MW2-0404	Mercury, total	0.0071 mg/L	0.002 mg/L
MW5-0404	Lead, total	0.024 mg/L	0.015 mg/L
MW7-0404	Tetrachloroethylene	12 µg/L	5 µg/L
	Trichloroethylene	10 µg/L	5 µg/L
	Arsenic, total	0.053 mg/L	0.05 mg/L
	Lead, total	0.087 mg/L	0.015 mg/L
	Mercury, total	0.022 mg/L	0.002 mg/L
	Selenium, total	0.062 mg/L	0.05 mg/L
MW8-0404	Arsenic, total	0.052 mg/L	0.05 mg/L
	Lead, total	0.027 mg/L	0.015 mg/L
	Mercury, total	0.33 mg/L	0.002 mg/L
	Selenium, total	0.061 mg/L	0.05 mg/L
MW9-0404	Arsenic, total	0.053 mg/L	0.05 mg/L
	Cadmium, total	0.005 mg/L	0.005 mg/L
MW10B-0404	Lead, total	0.042 mg/L	0.015 mg/L
MW13A-0404	Naphthalene	28 µg/L	20 µg/L
	Vinyl chloride	3.6 µg/L	2 µg/L
	Dibenz(a,h)anthracene	6.6 J µg/L	0.005 µg/L
	Mercury, total	0.0049 mg/L	0.002 mg/L
MW14-0404 (collected from well MW-14R)	Arsenic, total	0.33 mg/L	0.05 mg/L
	Cadmium, total	0.057 mg/L	0.005 mg/L
	Lead, total	0.016 mg/L	0.015 mg/L
	Mercury, total	0.0051 mg/L	0.002 mg/L
	Selenium, total	0.32 mg/L	0.05 mg/L
MW15-0404	Chromium, total	0.15 mg/L	0.1 mg/L
MW8-0404	Arsenic, total	0.095 mg/L	0.05 mg/L
	Selenium, total	0.05 mg/L	0.05 mg/L
MW20A-0404	Arsenic, total	0.10 mg/L	0.05 mg/L
	Cadmium, total	0.01 mg/L	0.005 mg/L
	Chromium, total	0.16 mg/L	0.1 mg/L
	Lead, total	1.0 mg/L	0.015 mg/L
	Mercury, total	0.0038 mg/L	0.002 mg/L
	Selenium, total	0.05 mg/L	0.05 mg/L

Sample ID	Substance	Concentration	NHDES AGQS ¹
MW20B-0404	Arsenic, total	0.077 mg/L	0.05 mg/L
	Lead, total	0.17 mg/L	0.015 mg/L
	Selenium, total	0.057 mg/L	0.05 mg/L
MW21-0404	Arsenic, total	0.063 mg/L	0.05 mg/L
	Lead, total	0.085 mg/L	0.015 mg/L
	Selenium, total	0.058 mg/L	0.05 mg/L

Notes: ¹ = NHDES Risk Characterization and Management Policy (Section 7.5(5), revised 4/27/04).

NHDES = New Hampshire Department of Environmental Services

AGQS = Ambient Groundwater Quality Standard

mg/L = milligrams per liter

µg/L = micrograms per liter

J = results estimated

The SVOC results were similar in distribution to those for VOCs, although there are no historic SVOC data for comparison with the WESTON results.

The concentration of mercury detected in shallow bedrock monitoring well MW-8 (0.33 mg/L) is three times greater than the highest historical concentration of mercury in groundwater (0.11 mg/L) detected at the Site, which was also in monitoring well MW-8, in August 1999 (T&B, 2001). Figure 4-1 summarizes total mercury concentrations in groundwater beneath the Site.

The concentration of lead detected in shallow overburden monitoring well MW-20A (1.0 mg/L) is 12 times greater than the highest historical concentration of lead in groundwater (0.082 mg/L) detected at the Site, which was detected in shallow bedrock monitoring well MW-4A, in August 1999 (T&B, 2001). Figure 4-2 summarizes total lead concentrations in groundwater beneath the Site.

Exceedances of NHDES AGQS for arsenic are comparable to previous data. Figure 4-3 summarizes total arsenic concentrations in groundwater beneath the Site.

Exceedances of NHDES AGQS for cadmium, chromium, and selenium have not been reported previously. Exceedances of NHDES AGQS for cadmium and chromium were much more limited than those of mercury, lead, arsenic, and selenium. Figure 4-4 summarizes total cadmium

6. CONCEPTUAL MODEL

Based on the information described above, WESTON has developed a conceptual model of the local hydrogeologic system and potential mechanisms for transport of mercury from the Site to the Androscoggin River. The conceptual model provides a summary of our understanding of site hydrogeology, the nature and extent of contamination, and an evaluation of potential receptors. The model should be revised where necessary as additional information becomes available regarding the Site. Figures 6-1 and 6-2 depict four cross-sections of the Site (cross-section locations are shown on Figure 5-1) that summarize WESTON's conceptual hydrogeologic model of the Site. The figures include surface and bedrock surface profiles, overburden and bedrock potentiometric surfaces, and hydrogeologically-important features.

6.1 GROUNDWATER FLOW

Groundwater at the Site and vicinity originates as precipitation falling on the Site and surrounding upland areas to the north and east. A portion of the precipitation runs off directly into the Androscoggin River. In the portions of the Site not underlain by the impermeable HDPE cover, the precipitation infiltrates into the ground, migrating vertically through the unsaturated zone until it reaches the overburden water table. The water then flows through overburden, perched upon the top of the bedrock surface until it reaches a fracture. Depending upon the potentiometric head in the given bedrock fracture, which has been demonstrated to be greater or less than the overburden potentiometric head (see Figure 5-4), water may enter the fracture and move vertically downward, or move upward from the bedrock fracture into the overburden. Based on the relative elevations of overburden groundwater measured in monitoring wells MW-18A/18B, MW-20A/20B and MW-22, it is clear that the slurry wall only partially retards the flow of groundwater laterally into the landfill. Based on the relatively low downward vertical groundwater flow gradients measured at monitoring well couplet MW-18A/18B (0.01 ft/foot) and relatively low upward vertical groundwater flow gradient measured at monitoring well couplet MW-20A/20B (0.04 ft/foot), it does not appear that the overburden groundwater elevations are strongly mounded on the outside of the slurry wall or significantly depressed on the inside of the slurry wall. These data suggest that overburden groundwater passes the slurry

wall by flow through the slurry wall, rather than by under-flow through the bedrock beneath the slurry wall.

Bedrock beneath the Site is fractured in a complicated pattern. Bedrock fractures, identified by both surficial bedrock fracture mapping by USGS of bedrock outcrops along the Androscoggin River and WESTON *Rock Coring Logs*, comprise a complicated pattern that includes folding and interruption of older planar features by more recent orogenic activities. Specifically, USGS mapping of local bedrock indicates that steeply dipping fractures within the Oliverian Plutonic Suite gneiss terminate on sub-horizontal contacts with New Hampshire Plutonic Suite pegmatites and on moderately dipping contacts with chlorite schist. Steeply northwest-dipping en-echelon fracture zones, parallel joint zones, and silicified brittle faults have strikes to the northeast. Gently east-dipping to sub-horizontal fractures in the gneiss strike northeast (USGS, 2004). The sub-horizontal New Hampshire Plutonic Suite pegmatites are generally unfractured, and serve to terminate vertical groundwater flow. In contrast, the ductile shear zones that are exhibited by the presence of the chlorite schist, show weathering, parting and vugs, which facilitate groundwater flow. However, as suggested by the spring 2004 interconnectivity testing, the interconnectivity of the discontinuous fractures is generally low.

Subsurface data collected from the Site indicate that a bedrock trough exists in the vicinity of the monitoring wells MW-2 and MW-7, and that an area of elevated bedrock is present beneath the center of the Site. The trough in the bedrock surface in the vicinity of monitoring well MW-7 trends easterly from the retaining wall along the Androscoggin River. USGS has mapped no easterly trending structures in bedrock at the Site. However, the USGS bedrock map depicts the area adjacent to the southwest end of the bedrock trough (expressed as the gap in bedrock data due to submerged bedrock) as fine-grained gneiss with orthogonal jointing. Such orthogonal jointing typically results in greater likelihood of erosion, and is interpreted by WESTON as reason for the bedrock trough. The *Rock Coring Log* for location MW-13B, located on the north side of the bedrock trough, indicates that the bedrock was competent, with high rock quality designation values, and contained common quartz veins and chlorite schist. However, coring had to be terminated below 40 ft due to shifting of the borehole walls, which caused excessive friction on the core barrel.

Groundwater flow direction in overburden is affected by the depth and slope of the bedrock surface and the availability of discharge points. During wetter periods, when the rate of groundwater recharge exceeds the rate at which water can move down into the bedrock, the overburden water table rises, and discharge via the pipe at the foot of the retaining wall at the western edge of the Site increases due to the increased water pressure. During drier periods, overburden discharge via the pipe and cap seep at the western edge of the Site decreases, and the majority of overburden groundwater discharge will be to shallow bedrock along the western edge of the Site, with a disproportionate amount occurring in the vicinity of monitoring well MW-7, where relatively high shallow bedrock hydraulic conductivity is combined with a strong downward vertical hydraulic gradient. The combination of relatively high shallow bedrock hydraulic conductivity and a strong downward vertical hydraulic gradient results in the depression in the overburden potentiometric surface observed during both wet and dry periods at monitoring well MW-2, relative to the other overburden wells at the Site. As shown by the estimated groundwater potentiometric surface contours on Figures 5-1 and 5-2, both overburden and shallow bedrock groundwater flow in a westerly direction towards the Androscoggin River, with preferential flow toward the vicinity of monitoring well MW-7.

The higher bedrock hydraulic conductivity along the western edge of the Site (noted particularly in the vicinity of monitoring well MW-7), relative to shallow bedrock below the eastern portion of the Site, is evidenced by the anomalously high downward vertical hydraulic gradient between monitoring wells MW-2 and MW-7. The higher bedrock hydraulic conductivity along the western edge of the Site is probably due to the increased likelihood of the bedrock water-bearing structures intersecting the ground surface, either above or below the Androscoggin River bed, rather than truncating or otherwise "dead-ending" within bedrock.

6.2 NATURE AND EXTENT OF CONTAMINATION

The analytical results of soil samples collected from soil borings within the landfill indicate the presence of the SVOCs atrazine, benzo(a)pyrene, and dibenz(a,h)anthracene; dioxins/furans; and the metals arsenic, beryllium, and mercury at concentrations that exceed NHDES S-3 Soil Standards. Soil sample analytical results documented that surficial soils south of the landfill contain benzo(a)pyrene, arsenic, and mercury at concentrations that exceed NHDES S-3 Soil

Standards. Review of soil boring logs from the area south of the landfill indicates the solidified material deposit noted along the riverbank does not extend as far as soil borings SB-01 through SB-06, and is likely a localized spill, subsequently covered by fill emplaced at an unknown time.

The analytical results of groundwater samples collected by WESTON document that a release of VOCs, SVOCs, and metals has occurred at the Site. Groundwater samples collected from the on-site monitoring wells in April 2004 indicate the presence of the VOCs, tetrachloroethene, trichloroethene, and VC; the SVOCs dibenz(a,h)anthracene and naphthalene; and the metals arsenic, cadmium, chromium, lead, mercury, and selenium at concentrations that exceed their NHDES AGQs in one or more monitoring wells. The highest concentration of mercury detected during the April 2004 sampling event was 0.33 mg/L in shallow bedrock monitoring well MW-8, located downgradient of the landfill and adjacent to the bank of the Androscoggin River.

WESTON's maps of the vertical and horizontal extent of arsenic, cadmium, chromium, lead, mercury and selenium contamination (Figures 4-1 through 4-6) show that overburden groundwater contains contaminants at higher concentrations on the eastern, upgradient side of the landfill, while shallow bedrock contains contaminants at higher concentrations on the western, downgradient side of the landfill. These figures show that contaminated groundwater is generated by contact with contaminants within the overburden material within the landfill, and that the contaminated groundwater migrates both westward across the landfill and downward, entering shallow bedrock along the western edge of the landfill.

Prior to the current investigation, it was presumed that elemental mercury had been released into overburden materials within the former cell house area, and had migrated downward into bedrock fractures under the force of gravity, until the bedrock fractures terminated, at which point, the mercury would collect. One of the goals of this investigation was to better constrain the distribution of mercury DNAPL in the overburden and bedrock, both horizontally and vertically. WESTON's approach to better constrain the distribution of mercury DNAPL was to install additional overburden and bedrock monitoring wells, and compare the concentrations of mercury detected in groundwater samples collected from the wells. Low-flow sampling techniques were used for two reasons: to minimize the loss of volatile mercury gas from the sample, and to avoid collection of samples containing mercury adsorbed to colloidal particles.

Figure 4-1 depicts the mercury concentrations detected in groundwater samples collected between April 7 and 8, 2004. The data indicate the highest mercury concentrations occurred in groundwater samples collected from shallow bedrock monitoring wells MW-7 and MW-8, at concentrations 0.022 and 0.33 mg/L, respectively. Based on the high concentration of mercury measured in MW-8, and the observance of mercury in nearby seeps, it appears that mercury DNAPL is located in bedrock in the vicinity of monitoring well MW-8. The data do not support a conclusion that mercury DNAPL extends to deeper bedrock in these areas, based on the non-detection of mercury in the groundwater sample collected from deep bedrock monitoring well MW-15. The subsurface data and analytical results from monitoring well MW-15, which is located south of well MW-8 (which is not a true couplet with MW-8) also suggest that southerly groundwater flow is restricted from well MW-8.

Based on the identification of fractures, chlorite schist shear zones, and quartz veins in the rock core log compiled for location MW-8, the most hydraulically-active zones within the bedrock may be between elevations 1,085 to 1,087 and 1,068 to 1,070 ft amsl. Pegmatite bodies that occur from 1,072 to 1,078 and 1,082 to 1,084 ft amsl at monitoring well MW-8 may serve to isolate the upper chlorite schist lenses from the lower quartz veins, and may have caused mercury DNAPL to perch. USGS hydrogeologic data regarding the strong hydraulic connection between monitoring wells MW-7 and MW-8 and the Androscoggin River further suggest that the features noted above are hydraulically-active, as their elevations are within the range of river stage elevations recorded by USGS, and are the likely interconnection that allows the strong correlation between river stage and groundwater level elevations in these wells.

Review of mapping of mercury occurrences at bedrock fractures along the banks of the Androscoggin River indicates that most liquid mercury occurrences appeared at outcrops located west and southwest of monitoring well MW-8, at elevations between 1,075 and 1,078 ft amsl. There is apparent preferential distribution between fracture type, with a majority of the liquid mercury seeps associated with chloritized or silicified zones versus joints. There appears to be no preferential concentration of elemental mercury seeps or deposits at feature intersections versus along single features. Northwest of monitoring well MW-8, and at slightly lower elevations, perhaps due to the absence of bedrock at higher elevations, is the area where the greatest concentration of solid metallic deposits (suspected to be a mercury amalgam) was noted. This

area is located to the west of monitoring well MW-7, and is interpreted by WESTON to represent historic mercury discharges. The greater hydraulic conductivity noted in monitoring well MW-7 suggests that mercury was more effectively purged from the bedrock fractures in this area. This is consistent with the USGS observation of the greater sensitivity of monitoring well MW-7 to river stage changes.

6.3 MERCURY TRANSPORT MECHANISMS

Mercury is being transported via bedrock fractures from the Site to the Androscoggin River, as evidenced by deposits of elemental mercury in liquid form, and other solid metal deposits that appear to be a mercury amalgam. The physical and chemical properties of mercury make several transport mechanisms through fractured bedrock possible. These mechanisms include gravity flow of elemental mercury DNAPL, migration of gaseous elemental mercury, and transport of aqueous solutions containing dissolved elemental mercury and/or divalent mercury. These mechanisms will each be discussed in more detail in this section.

6.3.1 Movement of Elemental Mercury Dense, Non-Aqueous Phase Liquid by Gravity

Elemental mercury is a DNAPL with respect to water, due to its much greater density (approximately 13.5 times that of water at ambient temperatures) (Windholz, 1983; MTS, 2004). Mercury DNAPL will flow downward through fractures and accumulate in areas where downward fractures terminate (D&S, 1990). The mechanism for the discharge of some of the mercury DNAPL to the Androscoggin River appears to be gravity driven, as it appears that mercury DNAPL may currently be perched at an elevation of approximately 1,078 or 1,084 ft amsl in the vicinity of monitoring well MW-8. USGS has measured the elevation of surface water of the Androscoggin River as fluctuating between 1,075 and 1,082 ft amsl (USGS, 2004). One plausible explanation for the observed mercury is that DNAPL may be slowly moving down from its perched location, where it presumably completely fills portions of the fractures available to it. Some of the fractures may reach the surface at lower elevations along the river, and allow the mercury DNAPL to reach the surface.

The transport mechanism of gravity flow through fractures does not explain the observations that most of the fractures where liquid mercury has been observed to discharge dip steeply downward

from a sub-horizontal bedrock surface, and that the fractures (where they can be inspected) are not filled with elemental mercury. A transport mechanism related to simple gravity movement of DNAPL is flow of DNAPL enhanced by hydrostatic pressure. Operational changes at Sawmill Dam can cause the river stage to drop up to 6 ft in less than 1 hour. These rapid changes in river stage are compensated for by the rapid discharge of groundwater to the surface, via fracture flow, as demonstrated by the rapid responses in monitoring wells MW-7 and MW-8. During these periods, it is possible that the hydrostatic head of the bank storage of groundwater could lift mercury DNAPL in certain fracture formations. For example, if the mercury DNAPL completely blocks portions of the fractures in which it has collected, sufficient hydrostatic head behind the mercury DNAPL may move the mercury DNAPL, rather than flowing around it. Based on the relative densities of mercury and water, the approximately 6 ft vertical hydraulic head would be sufficient to lift the mercury DNAPL approximately 1/14 the hydrostatic head, approximately 0.42 ft. The similar viscosities of mercury and water at the temperatures measured in groundwater (approximately 1.3 centipoise) would not impart any frictional disadvantage to mercury flow versus groundwater flow. However, the very high surface tension of elemental mercury creates forces that oppose movement of elemental mercury into small fractures (Henke et al., 1993).

6.3.2 Movement of Elemental Mercury in Gaseous Phase

The aqueous solubility of mercury is greatly affected by the oxidation state of mercury, which is typically either divalent [Hg(II)] or zero valence [Hg(0)]. Elemental mercury (zero valence mercury) is soluble in water as a gas. The concentration of elemental mercury gas in water would primarily be affected by temperature, decreasing with decreasing temperature (Sanemasa, 1975). Solubility of elemental mercury in water is expected to be approximately 20 to 30 µg/L at the range of well water temperatures measured at this Site, and less than 20 µg/L in the colder surface water temperatures expected during the winter. Elemental mercury in water seeks equilibrium with the gas phase at the groundwater surface. In areas where the groundwater contains elemental mercury gas and the groundwater surface occurs within fractured bedrock, such as the area between MW-8 and the river, elemental mercury will volatilize from groundwater toward a condition of equilibrium with the gas phase within the fractures above the groundwater surface. The concentration of mercury in the vapor phase above the groundwater

will vary based on temperature, relative humidity, barometric pressure, and other factors (Charlton et al., 1994). Air will move from the fractures to the openings of the fractures (where mercury DNAPL has been observed) under certain conditions (e.g., during periods of rising groundwater or falling barometric pressure). As the air in the fractures mixes with the ambient air, the chemical equilibrium in the air changes. If the ambient air is significantly cooler than the air escaping from the fracture, the elemental mercury gas could condense and deposit at the opening of the fracture. Particulate matter in the ambient air could also catalyze deposition of mercury from the air (Mackay et al., 1995). This condensation could be the mechanism responsible for the fine droplets of mercury observed disseminated in granular materials above bedrock fractures during mercury collection efforts. Under many conditions; however, the gaseous mercury escaping from the fractures would remain as a gas and escape into the atmosphere.

6.3.3 Movement of Mercury in Aqueous Phase

The solubility of mercury in aqueous solutions is dependent on a number of factors, including pH, temperature, oxidation-reduction (redox) potential, and the concentration of anionic ligands. The most important factor is the oxidation state of the mercury, since divalent mercury can be more than three orders of magnitude more soluble than elemental (zero-valent) mercury. Conversion of mercury from zero-valent to divalent form, and from divalent to zero valence form, can readily occur in the environment. Oxidation of mercury to divalent form is the favored reaction in most natural systems, particularly surface water (EPA, 1997; Veiga, et al., 1995).

Divalent mercury can be more than five orders of magnitude more soluble than elemental mercury in aqueous solutions, depending on a number of factors, including pH, temperature, oxidation-reduction (redox) potential, and the concentration of anionic ligands (Henke, et al., 1993; EPA, 1997; Wilmarth, et al., 2004; Schnitzer and Kerndorff, 1981). Divalent mercury is soluble at concentrations exceeding 50 mg/L over a wide pH range in the presence of organic acids, including naturally-occurring acids, such as tannic and fulvic acids. In the absence of organic ligands, the inorganic ions that typically control mercury solubility are sulfide and chloride. When organic ligands are not present, but sulfides are present, divalent

mercury has very low solubility at neutral pH, but solubility increases above 50 mg/L at pH above 9 (Wilmarth, et al., 2003; and Veiga, et al., 1995).

Groundwater pH beneath the Site ranged between 6.09 at monitoring well MW-11A and 12.02 at monitoring well MW-13B in April 2004. Groundwater temperatures beneath the Site ranged between 6.76 degrees Centigrade (°C) at monitoring well MW-18A and 11.40°C at monitoring well MW-10B in April 2004. Groundwater redox potentials beneath the Site ranged between -328.1 millivolts (mV) at monitoring well MW-20A and 68 mV at monitoring well MW-5 in April 2004.

Mercury stability diagrams, also known as Eh-pH diagrams, have been presented in the literature. The diagrams have been developed for systems containing various amounts of chloride, sulfur, carbon dioxide, organic acids, and other elements significant to the study of mercury solubility (Tromans, et al., 1996; Veiga, et al., 1995 EPA, 2001). None of these variables were analyzed in this study; therefore, there are insufficient data to determine whether any of these diagrams is directly applicable to the Site. Nevertheless, the diagrams are useful for predicting what form of mercury is favored when pH and redox potential changes. Given the above site conditions, the solubility of mercury, and the dominant form of mercury, could vary considerably from well to well at the Site. The high pH at MW-7 and MW-8 would clearly favor solubility of divalent mercury, most likely as a mercuric hydroxide. The low redox at MW-7 and MW-8, however, may favor reduction of mercuric hydroxide to elemental mercury. As groundwater moves through bedrock fractures from the vicinity of MW-7 and MW-8 toward the river, the groundwater encounters the hyporheic zone (the zone where river water mixes with groundwater within the fractures). In the hyporheic zone, the river water will cause the pH of the solution to fall, and the redox of the solution to rise, changing the favored equilibrium condition for mercury. It is possible that these changes could result in conversion of divalent mercury to elemental mercury, resulting in concentrations of elemental mercury that could greatly exceed its solubility. If this occurred, the elemental mercury would escape from the aqueous solution (as both DNAPL and gas) in the hyporheic zone. Deposits of DNAPL or mercury precipitates would gradually accumulate wherever they were formed. The DNAPL and gas would behave as described in the above subsections. Any precipitated mercury compounds formed would be

essentially immobile until the aqueous conditions changed. Mercury that remains soluble (either as divalent or elemental mercury) upon entering the river would be transported downstream.

Three other phenomena have been documented that may be affecting migration of aqueous mercury, and resulting in deposition of the observed elemental mercury:

- It has been observed at Cell House sites that reduction of divalent mercury migrating with groundwater can occur at iron surfaces. This phenomenon has resulted in deposits of elemental mercury in saturated soil immediately adjacent to the iron surfaces (Turner, 2004). It has also been documented that iron filings can catalyze reduction of divalent mercury in treatment systems. The mechanism is described as reductive precipitation and/or coprecipitation (Weisener, et al., 2004). It is possible this mechanism is occurring at this Site.
- Microbially-mediated reduction of mercury from divalent to zero valence has been studied extensively. Many naturally-occurring microbes contain the “*mer*-operon” necessary to perform this reduction (Morel, et al., 1998). It is possible there is a microbial biomass near the openings of the fractures that is effectively reducing a portion of the soluble divalent mercury as it emerges from the fractures.
- Photochemical reduction of mercury has also been documented, and may be enhanced by the presence of reduced metals, including divalent iron and divalent manganese (Morel, et al., 1998).

7. CONCLUSIONS AND RECOMMENDATIONS

WESTON has completed the planned hydrogeologic investigation activities associated with the Former Chlor-Alkali Facility Site in Berlin, New Hampshire. The investigation was conducted to evaluate source distribution and migration pathway(s) of elemental mercury DNAPL and other contaminants present in groundwater beneath the Site, and was performed in accordance with the revised work scope and budget prepared by WESTON on December 29, 2003 and approved by NHDES on January 12, 2004. The following are our principal findings:

- Analytical results of soil samples collected between ~~the~~¹⁹ 1999 and the present showed the presence of VOCs, PCBs, furans and metals, including mercury at the Site, at concentrations above NHDES Method 1 S-3 Soil Standards. WESTON soil sampling in 2004, documented that such contamination extends southward beyond the landfill, in the vicinity of soil samples SB-01 through SB-06, where SVOCs, arsenic, and mercury exceed NHDES Method 1 S-3 Soil Standards in surface and subsurface soils.
- The source of the dark tar-like material noted along the banks of the Androscoggin River south of the landfill was not found below ground upslope of the material. WESTON found that the overburden in this area is primarily fill, and concludes that the solidified material was likely deposited on the ground surface south of soil borings SB-01 through SB-06, and was subsequently partially covered with fill.
- Analytical results of groundwater samples collected between ~~the~~¹⁹ 1999 and the present, showed the presence of VOCs and metals, including mercury beneath the Site, at concentrations above applicable NHDES AGQs. Groundwater quality exceeded NHDES AGQs in overburden along the eastern side of the landfill, and extended downward to the west and southwest, into shallow bedrock. Overburden groundwater along the western side of the landfill typically contains lower concentrations of contaminants than the shallow bedrock groundwater underlying it.
- WESTON hydraulic conductivity testing indicates that overburden hydraulic conductivity is generally one to three orders of magnitude greater than in the underlying shallow bedrock. A zone of elevated hydraulic conductivity in shallow bedrock crosses the Site, trending northwestward between shallow bedrock monitoring wells MW-20B and MW-7.
- WESTON groundwater elevation and vertical hydraulic gradient calculations indicate that the slurry wall located along the eastern edge of the landfill is only a partial barrier to lateral groundwater flow through overburden. Available vertical hydraulic gradient data suggest that the slurry wall is subject to through-flow, rather than under-flow.

- Bedrock well interconnectivity testing performed by WESTON indicates that a few well pairs are interconnected, but that the majority of bedrock fractures are discontinuous at the scale of the Site. Bedrock fracture interconnectivity results in the fracture zone interpreted in the vicinity of well MW-7 were inconclusive due to interference by river fluctuations.
- USGS detailed bedrock mapping shows that bedrock beneath the Site is primarily gneiss, containing sub-horizontal, tabular pegmatites and discontinuous lenses of chlorite schist. Steeply-dipping fractures within the gneiss tend to truncate on the relatively unfractured pegmatites and chlorite schist lenses. These features control fracture interconnection and groundwater flow direction.
- WESTON 2004 groundwater analytical results indicate that mercury DNAPL is likely present in shallow bedrock in the vicinity of monitoring well MW-8. This mercury DNAPL may be perched on top of pegmatite bodies at this location. This indication of mercury DNAPL is consistent with the observation of liquid mercury seeps west and southwest of monitoring well MW-8.
- Strong correlations are noted between WESTON 2004 groundwater analytical results, USGS 2003 geophysical surveys, WESTON 2004 shallow bedrock hydraulic conductivity measurements, and the occurrence of mercury seeps at the Site. The area west and southwest of monitoring wells MW-7 and MW-8 has elevated mercury concentrations in groundwater, electrical conductivity, hydraulic conductivity, and common observations of liquid and solid mercury deposits.
- Three distinct mercury transport mechanisms may contribute in part to the observed elemental mercury deposits in the river. Mercury DNAPL may be discharging to the surface by gravity flow, with or without the assistance of hydraulic head. Elemental mercury vapor may be released from groundwater into bedrock fractures, and then redeposited at the openings of the fractures. Soluble mercury (zero-valent and/or divalent) may be transported via groundwater and rendered insoluble upon mixing with river water in the hyporheic zone, resulting in deposition of mercury.

As described in the preceding sections of this report, the additional data and interpretations presented in this report invoke several additional questions and identify additional data gaps. Based on the data and interpretations contained within this report, WESTON has prepared two sets of recommendations. The first set of recommendations can be done in the near future with limited investment of resources. The second set of recommendations pertain to the long-term goals of the site investigation and remediation project.

The near-term recommendations are to further evaluate the chemistry of groundwater, in order to better assess the three suggested mercury transport mechanisms, by performing the following work at wells MW-8, MW-7 and MW-14R:

- Perform field measurements of mercury vapor in groundwater samples using the static headspace analysis method, to evaluate the vapor transport of mercury dissolved in groundwater (Kriger and Turner, 1994).
- Perform simple field experiments to determine whether elemental iron can reduce the mercury in groundwater samples, as measured by mercury vapor in sample headspace following addition of iron filings, to evaluate dissolved mercury transport and deposition at the groundwater/surface water interface.
- Perform titration of groundwater (using sulfuric and hydrochloric acid), while measuring mercury vapor in head space and observing whether precipitates are formed, to evaluate dissolved mercury transport and deposition at the groundwater/surface water interface.
- Perform laboratory analysis of groundwater samples from these three wells and samples from the Androscoggin River, to better predict the behavior of groundwater when mixed with river water. Laboratory analyses would include major cations (sodium, calcium, magnesium, iron, aluminum, manganese), major anions (chloride, sulfate, sulfide), alkalinity, dissolved organic matter, and unfiltered mercury. Analyze a filtered sample from each well for zero-valent and total (zero-valent and divalent) mercury. These analyses would provide data to evaluate dissolved mercury transport and deposition at the groundwater/surface water interface

The longer-term recommendations are:

- Continued elemental mercury removals: NHDES should continue the annual removal of elemental mercury from the bedrock along the banks of the Androscoggin River, between late June and late August.
- Analysis of the dark tar-like material noted along the bank of the Androscoggin River: Collect and analyze a sample of the suspect material for TCL organics and TAL metals, to determine if it contains hazardous constituents.
- Perform additional shallow and deep bedrock monitoring well installations at the Site. WESTON recommends that the following additional monitoring wells be installed:
 - A deep bedrock monitoring well coupled with existing monitoring wells MW-16A and B, to further assess bedrock groundwater flow in this area.
 - A shallow bedrock monitoring well located near deep bedrock well MW-15, to further assess the shallow bedrock hydraulic conductivity and connectivity in this

area, which is believed to be low, limiting southward migration of mercury in bedrock groundwater.

- A shallow bedrock monitoring well located near piezometer P-19, to further assess the elevation of the bedrock surface in this area and shallow bedrock hydraulic conductivity in this area, which is expected to be relatively high.
- Additional monitoring well sampling: Following the installation of the recommended additional monitoring wells, WESTON recommends that groundwater quality monitoring of the monitoring wells be conducted at the Site. The samples should be submitted for laboratory analysis of metals according to the EPA Scope of Work. These data can be used to determine mercury concentrations at the Site, identify areas suspected to contain mercury DNAPL, and to monitor the nature and direction of groundwater flow in the local overburden and bedrock.
- Dye tracer testing of monitoring wells: Dye tracer testing of monitoring wells MW-20A and 20B, and MW-22 could further define whether the slurry wall is subject to through-flow, rather than under-flow.